

Final Report

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Fatigue Strength and Evaluation of Sign Structures Volume 2: Sign Structure Inspection Manual

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1. Introduction

This sign structure inspection manual is to be used by inspection engineers of the Indiana Department of Transportation (INDOT). It may be used to assist in the inspection of cantilever structures, overhead bridge structures (including tri-chord and box-truss sign structures), and monotube structures.

This manual outlines appropriate procedures and inspection interval recommendations to mitigate fatigue and fracture problems. It identifies critical spots in the various sign structures where fatigue could be a problem and provides recommendations for the inspection engineers on when and where to perform an inspection of the sign structures.

2. In-Service Inspection

Inspection of sign structures is essential to maintain the safety of the inventory of sign structures. It is required in the Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO 2001). The effectiveness of the sign structure inspection depends on good safety procedures, a well-developed inspection plan, and appropriate inspection methods. Sign structures should be inspected by trained inspectors who have an understanding of the load paths of the structure and the particular types of discontinuities that could be expected in these structures. The inspection should be thorough to ensure that a complete examination of all critical components is achieved.

Inspection is a difficult and expensive process. It is not possible to inspect every part of a sign structure for fatigue cracking with equally great effort due to limited time and financial resources available for sign inspections. Consequently, important sign structural details are identified in this manual, which will help to facilitate the inspection and reduce the cost involved in conducting the inspection.

A general sign structure inspection procedure is introduced in this section. The inspection of each component of a sign structure is reviewed. Then the “hot spots” for each type of sign structure of interest are identified.

2.1 Inspection Frequency

Based on an analytical program studying fatigue life of different types of sign structures under natural wind loading, recommendations for maximum inspection intervals were developed. Sign structures were classified into two groups, Class A and Class B, according to the estimated severity of fatigue damage caused by wind loads. Double-mastarm cantilever sign structures and single-mastarm cantilever sign structures belong to Class A. They are more susceptible to wind-induced fatigue damage than are other sign structures. It is recommended that Class A sign structures be inspected at a maximum time span of 4 years. Overhead bridge structures (including tri-chord and box-truss sign structures) and monotube sign structures are classified as Class B. They are less susceptible for wind-induced fatigue damage. It is

suggested that Class B sign structures be inspected at an interval of no more than 8 years.

2.2 Inspection Personnel

The inspection should be performed by at least two people. One of the two inspection engineers should meet the qualifications in the Bridge Inspector's Training Manual (Hartle et al., 1995). The qualifications of personnel are stated in Article 650.307 of Appendix A in the Bridge Inspector's Training Manual. Safety of the inspectors is of prime importance. All inspectors should be properly trained in the inspection process, climbing techniques, fall protection, safety and use of all equipment, and traffic control.

2.3 Sign Structure Inspection Procedure

The sign structure inspection procedure may vary in some steps, based on the types of sign structures to be inspected, availability of inspection equipment and inspector's decision. But a general inspection procedure similar to the inspection procedure in the Iowa inspection manual (Iowa Department of Transportation et al, 1999) can be proposed as the following:

- (1) Arrive at site.
- (2) Locate structure in record.
- (3) Begin traffic control.
- (4) Perform inspection and record inspection results:
 - Foundation
 - Anchor rods, nuts and washers
 - Support post or support frame
 - Span-to-support connection
 - Mast arm or truss members and welds, splices, attachments
 - Measurement of vertical clearance
- (5) Review the inspection results and make repair recommendations if necessary.
- (6) Remove traffic control and leave site.

2.4 General Introduction of Component Inspection

This section describes how components in the sign structures should be inspected.

2.4.1 Foundation and Grout Pad

Concrete foundations should be visually inspected for impact damage, spalling, scaling, and surface cracking. Sub-surface cracking can be located by using a hammer to lightly tap the concrete surface. A dull sound indicates the existence of a crack or other subsurface problems. Exposed reinforcing steel should be noted. All defects should be recorded by type, location and severity.

Grout pads should be visually inspected for cracks, loss of grout, and moisture accumulation. Measure the distance between the top of the concrete and the bottom of

the leveling nuts. The distance is excessive if it is greater than the anchor rod diameter (Dexter and Ricker, 2002).

2.4.2 Anchor Rods

Anchor rods, nuts, and washers should be visually inspected for corrosion, missing nuts and washers, and nuts not fully engaged. If there is corrosion near the interface between the anchor rod and the concrete, it may be an indication that there is more corrosion below the interface because moisture tends to accumulate at the interface between the concrete and anchor rod. Note any anchor rods that are significantly misaligned or were bent to fit in the baseplate hole. The top of the anchor rod should be struck lightly with a hammer. A dull sound may indicate a fatigue crack in the anchor rod. The washers and nuts should also be lightly struck with a hammer to detect looseness of these components. The sounding inspection is very important because it can identify ineffective anchor rods. If some anchor rods are not carrying loads as designed, stress in the other components may be increased significantly and future problems can easily arise.

If an anchor rod is identified as problematic by the sounding method, an ultrasonic technique may be utilized to verify the existence of cracking and help to decide what repair is necessary.

2.4.3 Support Post or Support Frame

Check the coverage of the galvanized coating and the existence of any rust on the components. If surface corrosion is observed, the adjacent area should be sounded by a hammer to detect corrosion of the weakened section. Also, sound the lower part of the support post using the hammer for signs of internal corrosion or water. Drain holes should be inspected to avoid accumulating dust or water in the post. For the post-to-base-plate weld connection, inspect the weld toes adjacent to both the post and the base plate for cracks. If there are stiffeners on the base plate, inspect the weld around the stiffeners. The hand holes should be inspected for cracks in the weld and along the weld toe. Missing hand hole covers should be noted and replaced as necessary. The splices between tubes are also important locations for inspection of cracks. All truss connections in support frames should be checked carefully for defects.

2.4.4 Horizontal Spans

The span camber of the space frame should be checked to identify if there is excessive sagging. The members (mastarms or truss members) of the horizontal spans should be inspected to see if the members are buckled, bent, ruptured, split or missing. All welded or bolted connections should be inspected for fatigue cracks. The following locations should be checked carefully: mastarm-to-post connections, splices between mastarms, and the truss connections near midspan and the ends. The mastarm-to-post connection is susceptible to fatigue damage, especially in the welds of the gusset plate and the surrounding area. As for the truss connections, the maximum forces in cantilever type sign structures occur at the end of the horizontal

span. So the truss members near the end of the span should be checked very carefully. In bridge type sign structures, the maximum forces occur at the chords near middle span and the truss members near the end of the span. So these members should be inspected carefully.

Bolts used in the splice connections should be manually checked for tightness. Striking the bolt with a hammer is a quick way to check the tightness of the nuts and bolts. Care should be used, however, since the hammer could be a potential threat to other workers and pedestrians below the sign structure span.

Walkways should be inspected for collision impact damage. If damaged walkways are found, they should be repaired immediately or removed to avoid a safety problem. The catwalks and lights are supported by brackets that are connected to the chords with U-bolts. The U-bolts should be inspected for tightness and full engagement of the nuts. Handrails should be inspected for missing hinge bolts and rusted or missing safety chains.

Signs should be inspected for peeling or delamination of the sign paint. If damage is found, the damaged sign panel should be photographed and recorded.

2.5 Inspection of Sign Structure Components

The following sign structures used in the State of Indiana are covered in this manual: double-mastarm cantilever sign structures, single-mastarm cantilever sign structures, tri-chord sign structures, box-truss sign structures, and monotube sign structures. This section describes the inspection guidelines for the structural details of these sign structures. The focus of the sign structure inspection is also mentioned.

2.5.1 Double Mastarm Cantilever Sign Structure

The double mastarm cantilever sign structure consists of a two-dimension frame supported at one end by a steel post. Vertical and diagonal truss members are welded between the two parallel mastarms to form the frame. A double mastarm cantilever sign structure is shown in Fig.1 and the locations of several important structural details are marked.

The following is an introduction and illustration of what should be inspected for each detail in the double mastarm cantilever sign structure.

Double Mastarm Cantilever Sign Structure

Overall View

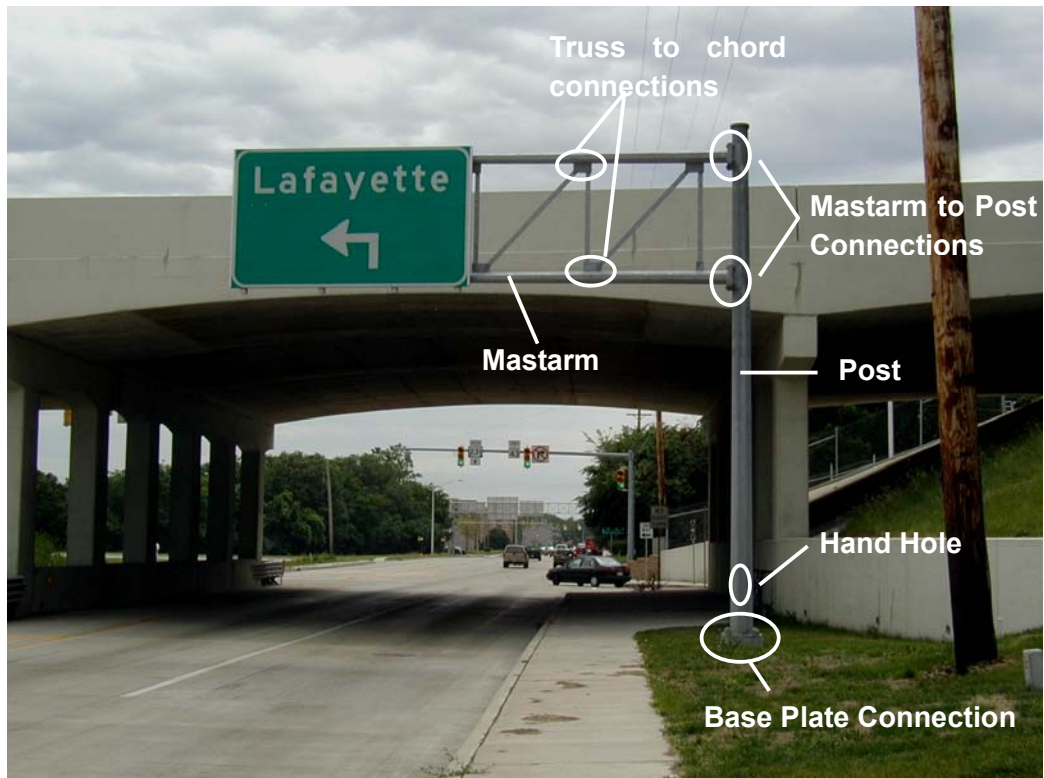


Fig. 1: Double mastarm cantilever sign structure.

Take a look at overall condition of structure. Make note of the following:

- Overall corrosion
- Abnormal global deformation of foundation, post and truss frame
- Clearance between truss frame and roadway surface

Double Mastarm Cantilever Sign Structure

Foundation



Fig. 2: Foundation of a double mastarm cantilever sign structure.

Remove metal skirt and check foundation for:

- Debris accumulation
- Impact damage, spalling, scaling and surface cracking (especially around anchor rods)
- Sub-surface crack (sounding with a hammer – dull sound indicates existence of cracking)

Check base plate for:

- Corrosion on surface
- Cracks at the edge or around holes
- Levelness

Double Mastarm Cantilever Sign Structure

Anchor Rods

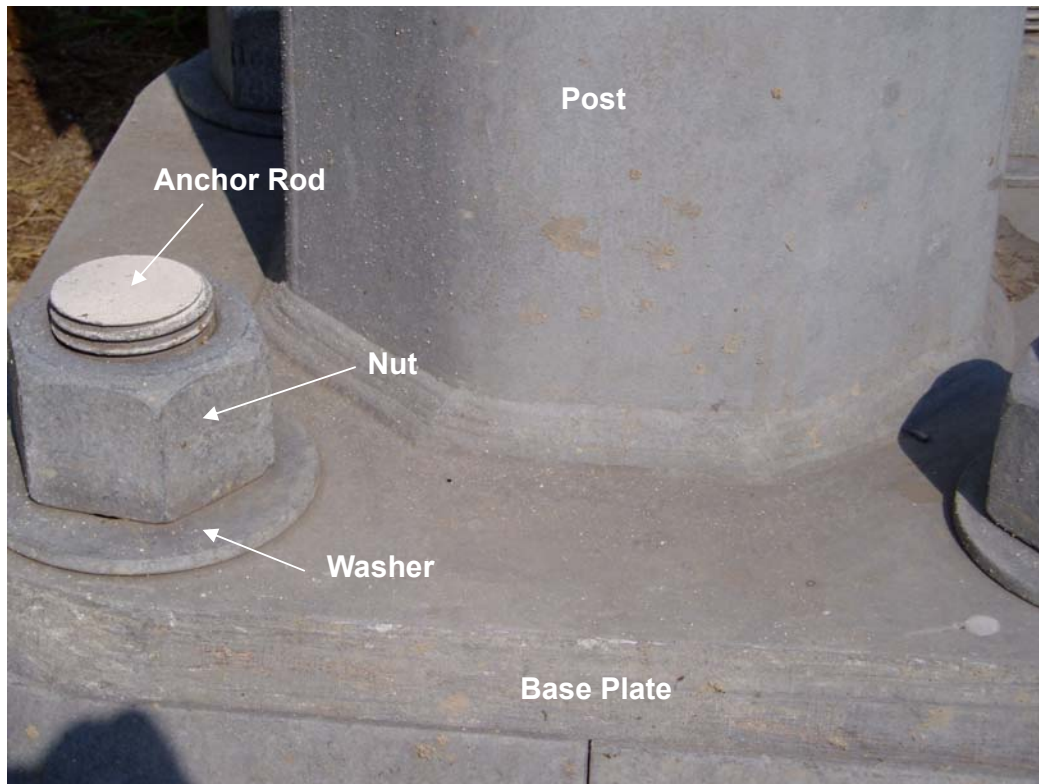


Fig. 3: Anchor rod detail of a double mastarm cantilever sign structure.

Remove metal skirt and check anchor rods for:

- Missing nuts or washers
- Tightness of nuts (tapping washer with a hammer)
- Condition of anchor rod by sounding (tap anchor rod on the top – dull sound indicates possible fracture in anchor rod)
- Thread damage in anchor rod (especially first thread under bottom nut if accessible)
- Corrosion on surfaces of anchor rod, nut and washer

Double Mastarm Cantilever Sign Structure

Post-to-Base-Plate Weld Connection

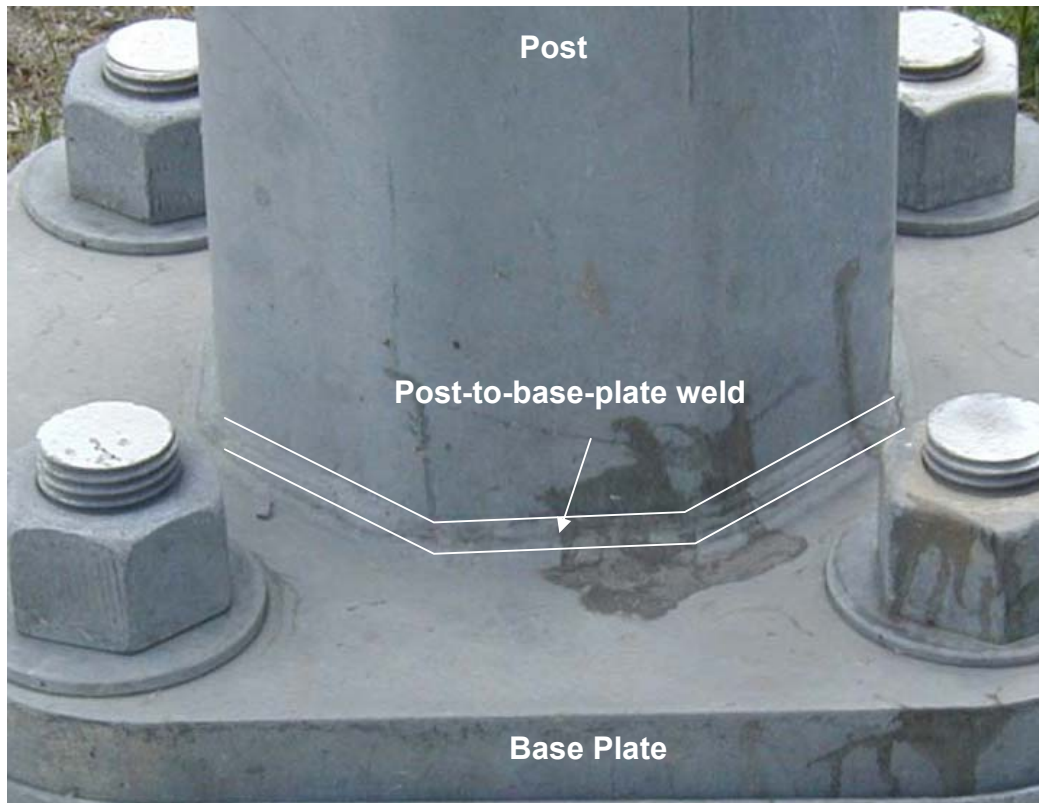


Fig. 4: Post-to-base-plate detail of a double mastarm cantilever sign structure.

Check post-to-base-plate weld for:

- Cracks and irregularities along weld toes
- Corrosion of welds

Double Mastarm Cantilever Sign Structure

Support Post

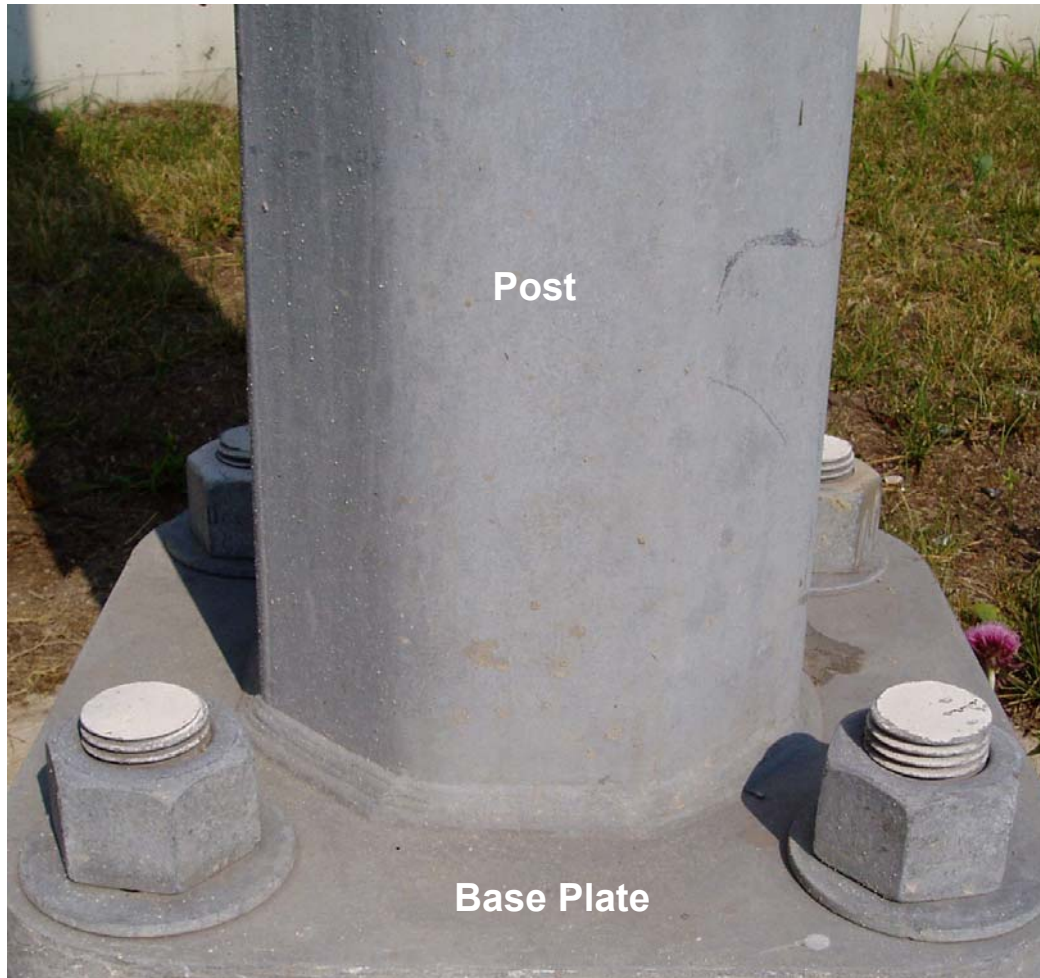


Fig. 5: Support post of a double mastarm cantilever sign structure.

Check post for:

- Coverage of galvanized coating and existence of any rust on post (sound rusted area with a hammer to identify any weakened sections)
- Signs of internal corrosion (sound lower part of post – dull sound indicates corrosion)

Double Mastarm Cantilever Sign Structure

Hand Hole

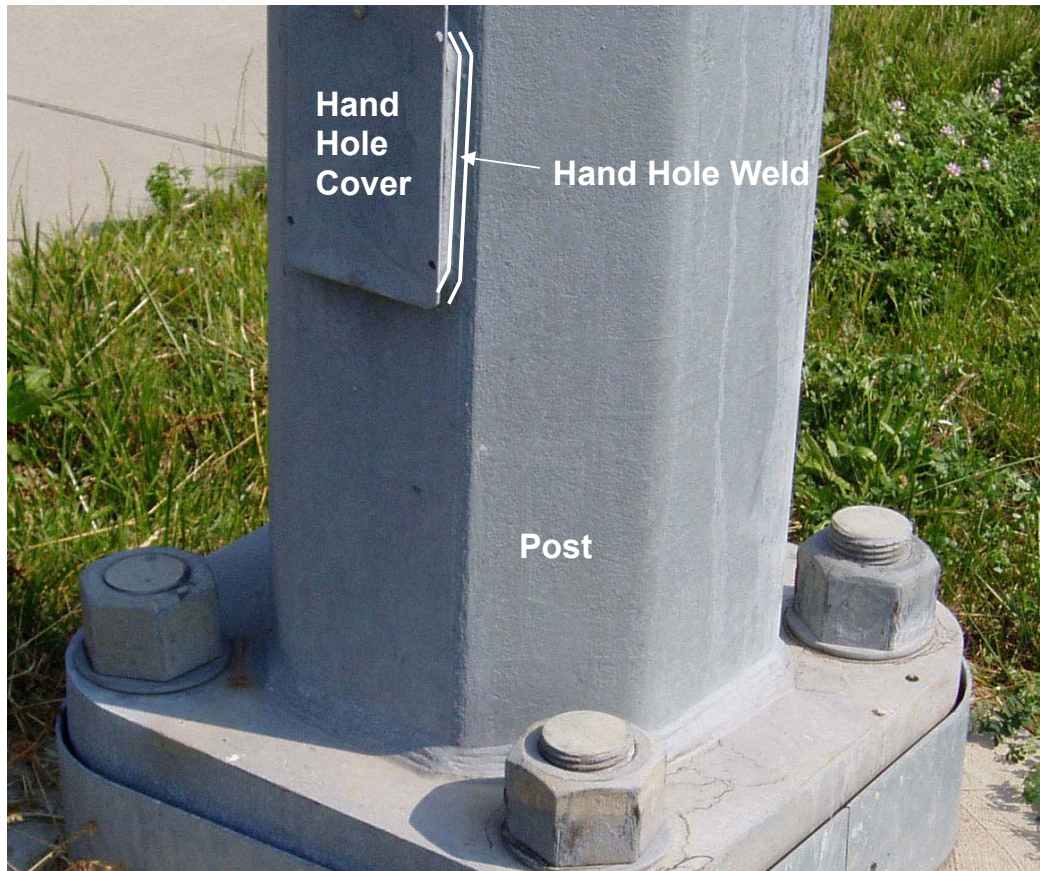


Fig. 6: Hand hole of a double mastarm cantilever sign structure.

Check hand hole for:

- Cracks and irregularities along weld toe around hand hole
- Corrosion on hand hole
- Corrosion of welds around hand hole
- Missing hand hole cover

Double Mastarm Cantilever Sign Structure

Mastarm-to-Post Bolted Connection

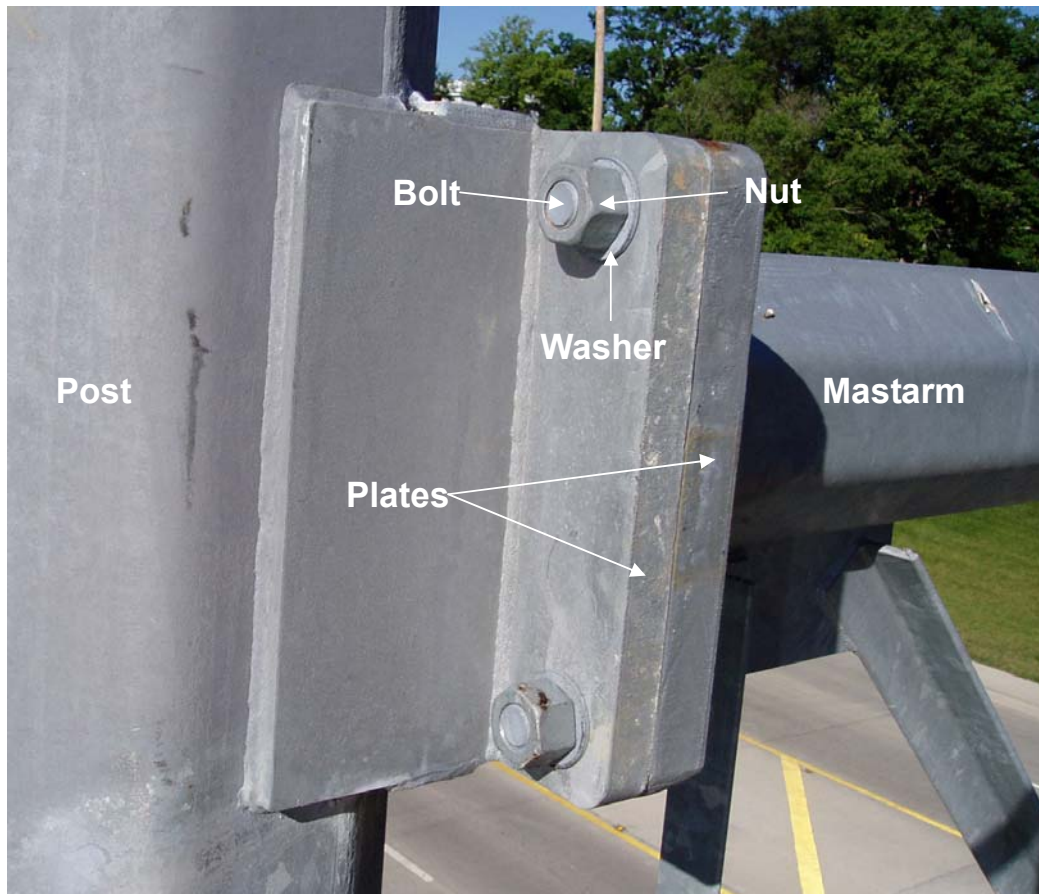


Fig. 7: Mastarm-to-post bolted connection for a double mastarm cantilever sign structure.

Check mastarm-to-post bolted connection for:

- Missing nuts or washers
- Tightness of nuts (tapping washer with a hammer)
- Condition of bolt by sounding (tap bolt on the top – dull sound indicates possible fracture in bolt)
- Corrosion on surfaces of bolt, nut, washer, and plates
- Signs of corrosion between two plates
- Cracks around bolt holes

Double Mastarm Cantilever Sign Structure

Built-up Box

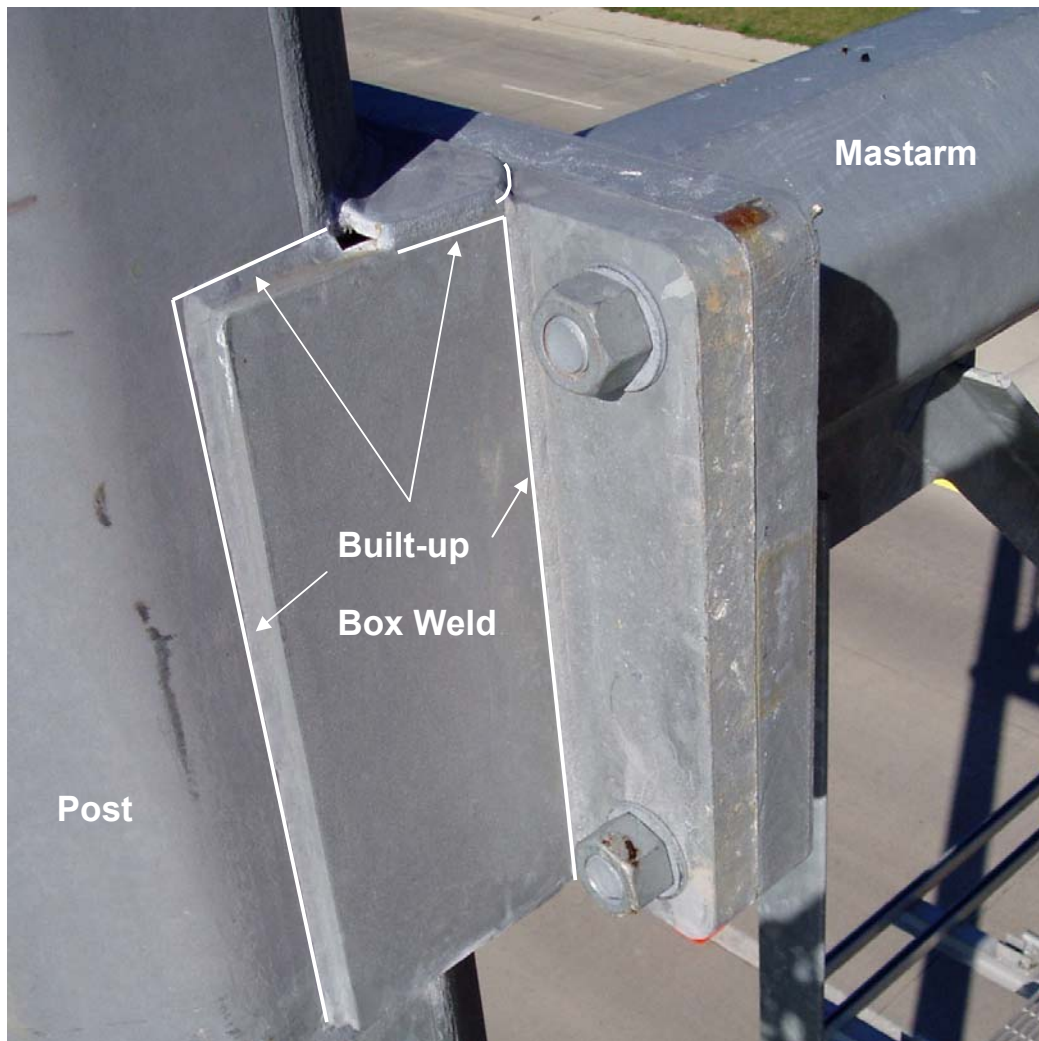


Fig. 8: Built-up Box of a double mastarm cantilever sign structure.

Check built-up box for:

- Cracks and irregularities along weld toes
- Corrosion on surfaces of built-up box
- Corrosion of welds

Double Mastarm Cantilever Sign Structure

Mastarm-to-End-Plate Weld Connection

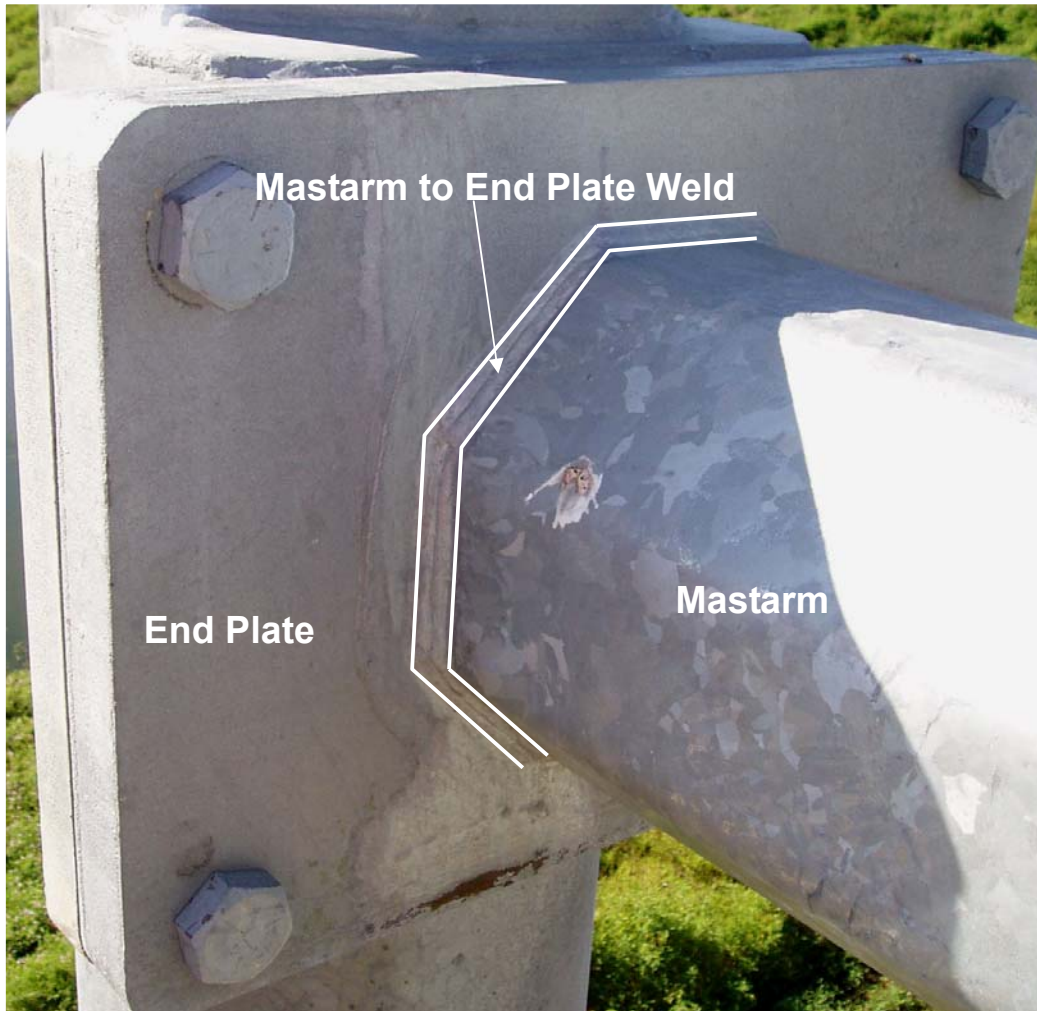


Fig. 9: Mastarm-to-end-plate weld connection for a double mastarm cantilever sign structure.

Check mastarm-to-end-plate weld connection for:

- Cracks and irregularities along weld toes
- Corrosion of welds

Double Mastarm Cantilever Sign Structure

Truss Weld Connection

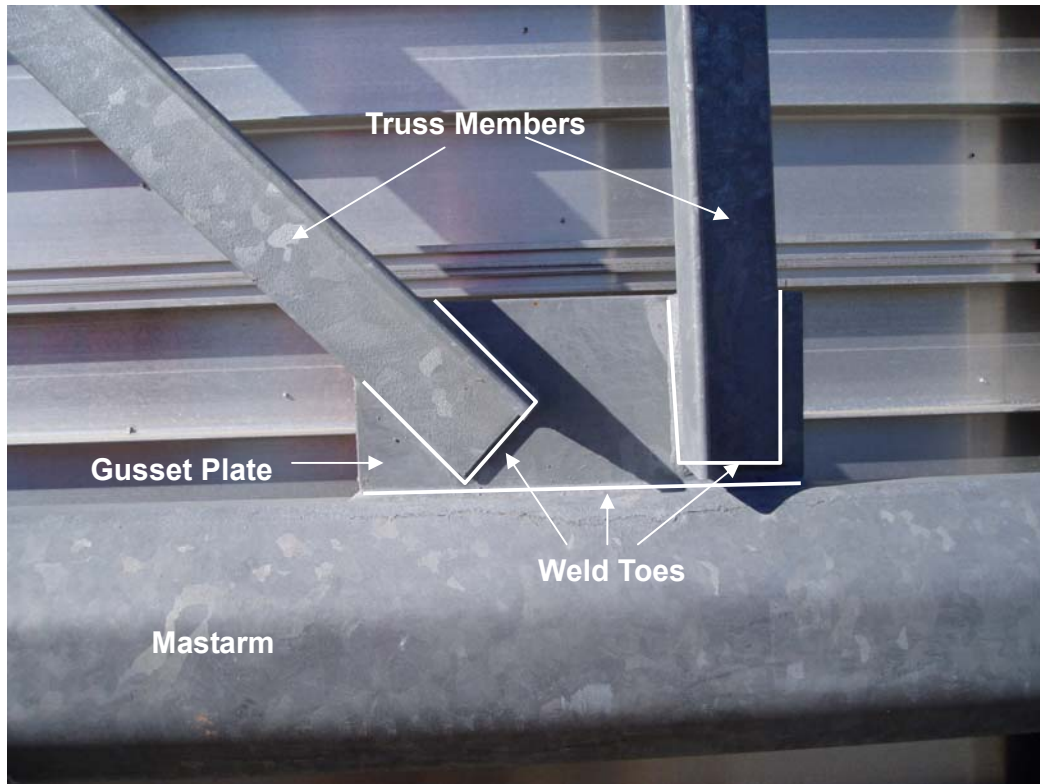


Fig. 10: Truss weld connection for a double mastarm cantilever sign structure.

Check truss member and gusset plate weld connection for:

- Cracks and irregularities at weld toes
- Corrosion on truss members, gusset plates, and mastarms
- Corrosion of welds

Double Mastarm Cantilever Sign Structure

Walkway Bracket or Sign Bracket Connection



Fig. 11: U-Bolt Connection of Walkway and Sign Bracket.

Check U-Bolts that connect mastarm to the sign and walkway bracket:

- Check to see if the U-bolts are tight
- Corrosion on the U-bolt threads or bracket connection

2.5.2 Single Mastarm Cantilever Sign Structure

The single mastarm cantilever sign structure consists of a single support post and a single cantilever arm. Both members are tapered. A single mastarm cantilever sign structure and the locations of several important structural details are shown in Fig. 11.

The following is an explanation of what should be inspected for each of the critical details in the single mastarm cantilever sign structure.

Single Mastarm Cantilever Sign Structure

Overall View

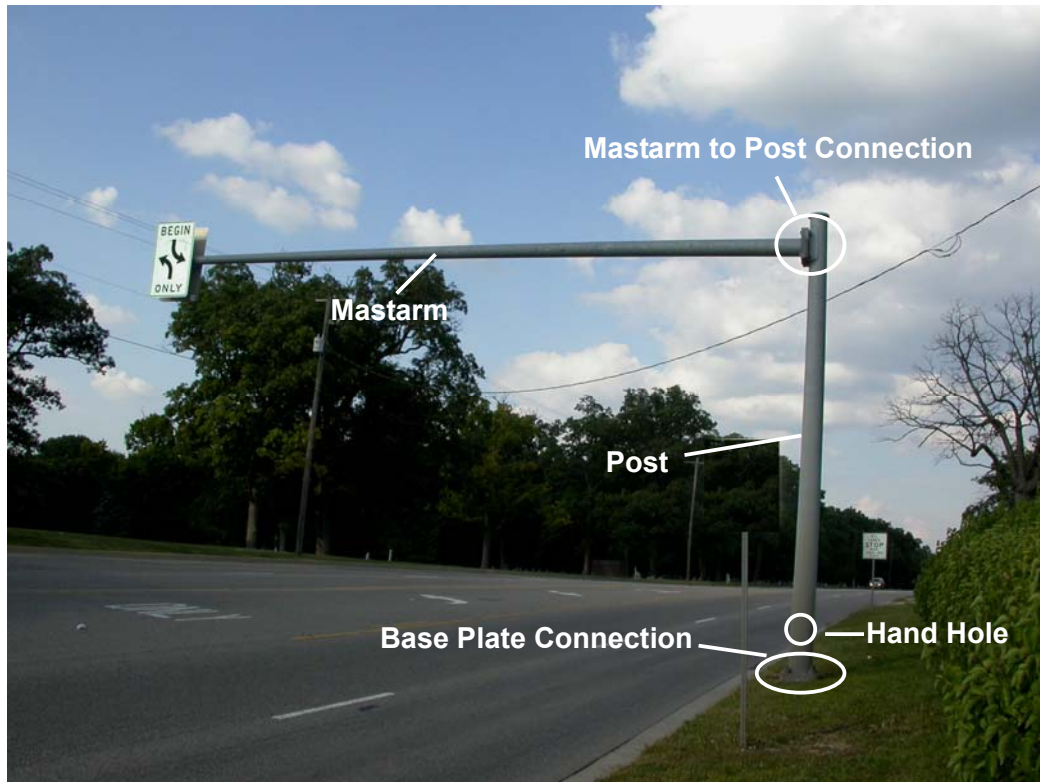


Fig. 12: Single mastarm cantilever sign structure.

Take a look at overall condition of structure. Make note of the following:

- Overall corrosion
- Abnormal global deformation of foundation, post and mastarm
- Clearance between mastarm and roadway surface

Single Mastarm Cantilever Sign Structure

Foundation

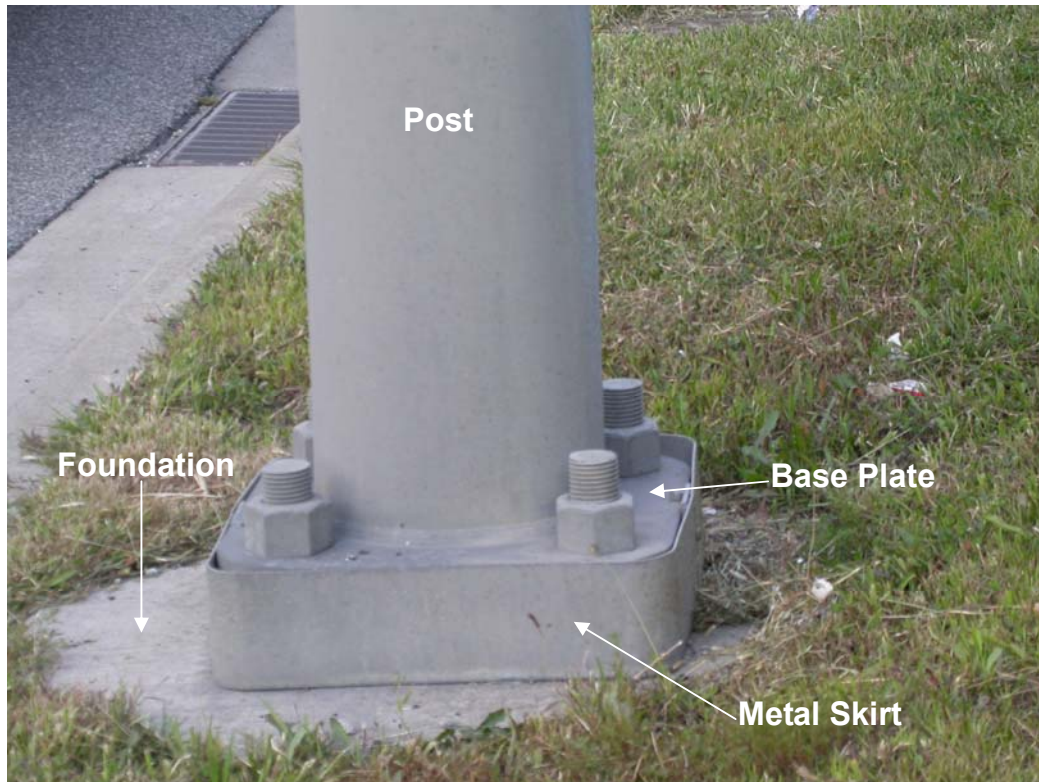


Fig. 13: Foundation of a single mastarm cantilever sign structure.

Remove metal skirt and check foundation for:

- Debris accumulation
- Impact damage, spalling, scaling and surface cracking (especially around anchor rods)
- Sub-surface crack (sound with a hammer – dull sound indicates existence of cracking)

Check base plate for:

- Corrosion on surface
- Cracks at the edge or around holes
- Levelness

Single Mastarm Cantilever Sign Structure

Anchor Rods

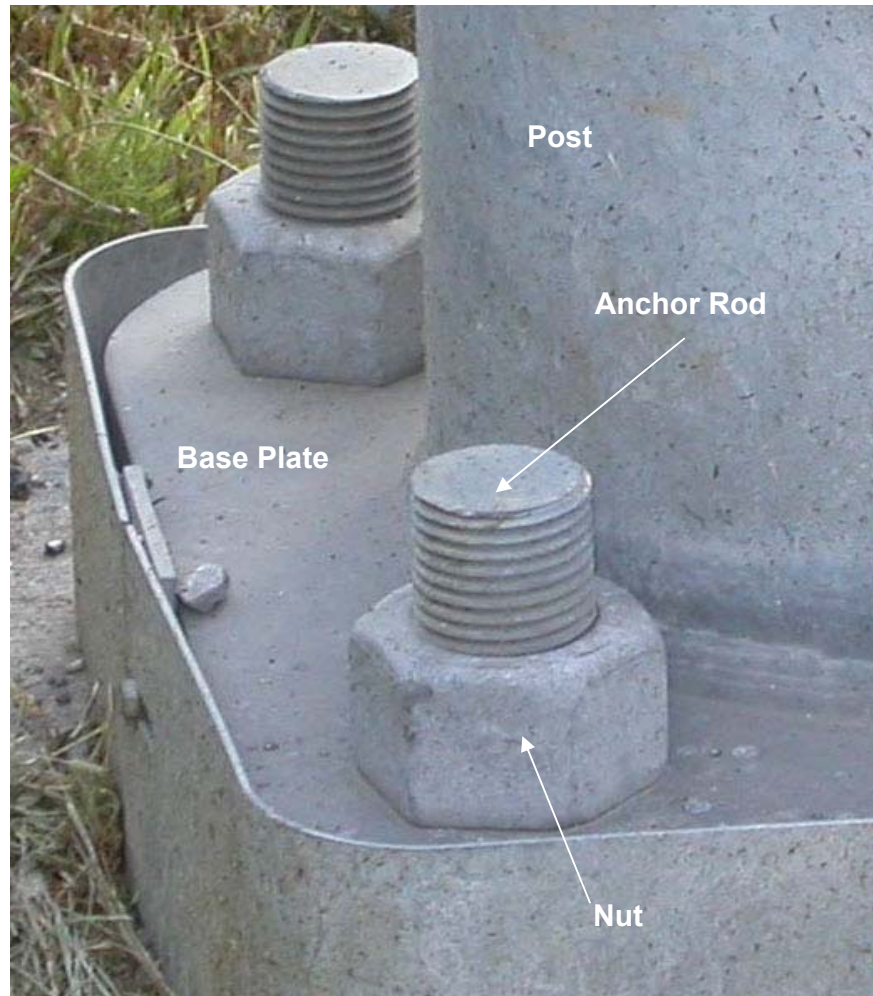


Fig. 14: Anchor rods detail of a single mastarm cantilever sign structure.

Remove metal skirt and check anchor rods for:

- Missing nuts
- Tightness of nuts (tap nuts with a hammer)
- Condition of anchor rod by sounding (tap anchor rod on the top – dull sound indicates possible fracture in anchor rod)
- Thread damage in anchor rod (especially first thread under bottom nut if accessible)
- Corrosion on surfaces of anchor rod, and nuts

Single Mastarm Cantilever Sign Structure

Post-to-Base-Plate Weld connection

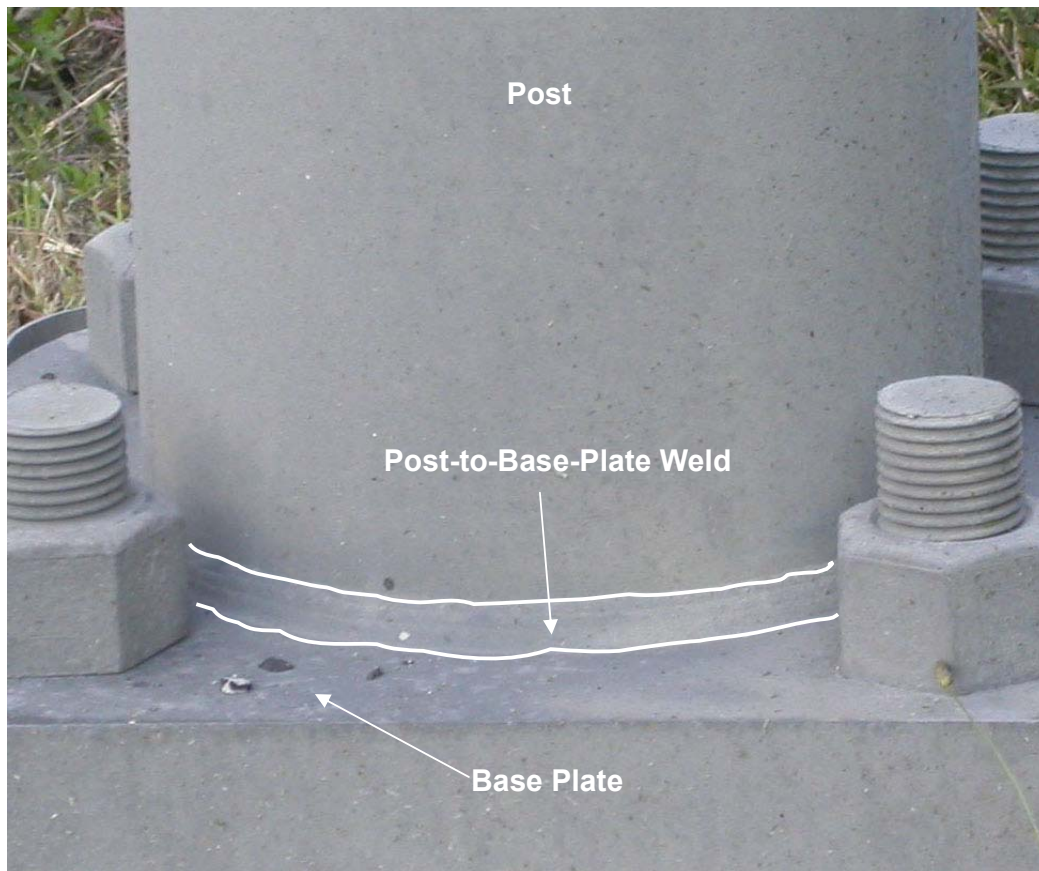


Fig. 15: Post-to-base-plate weld detail of a single mastarm cantilever sign structure.

Check post-to-base-plate weld for:

- Cracks and irregularities along weld toes
- Corrosion of weld

Single Mastarm Cantilever Sign Structure

Support Post

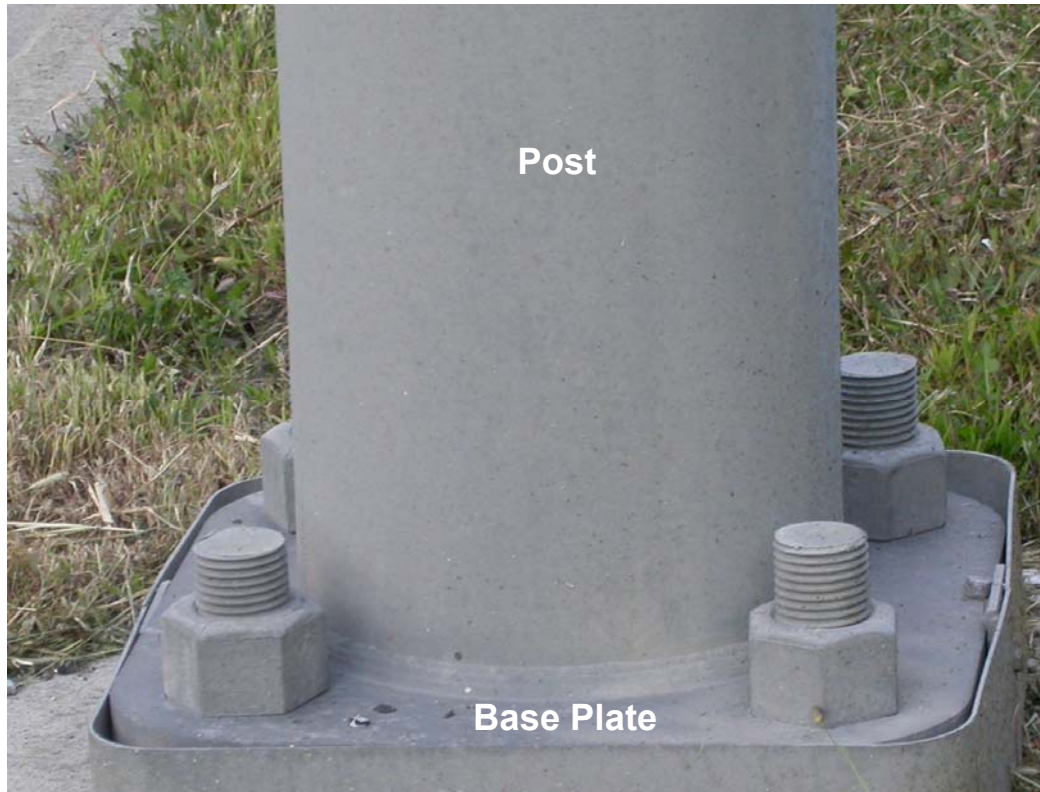


Fig. 16: Support post of a single mastarm cantilever sign structure.

Check post for:

- Coverage of galvanized coating and existence of any rust on post (sound rusted area with a hammer to identify any weakened sections)
- Signs of internal corrosion (sound lower part of post – dull sound indicates corrosion)

Single Mastarm Cantilever Sign Structure

Hand Hole

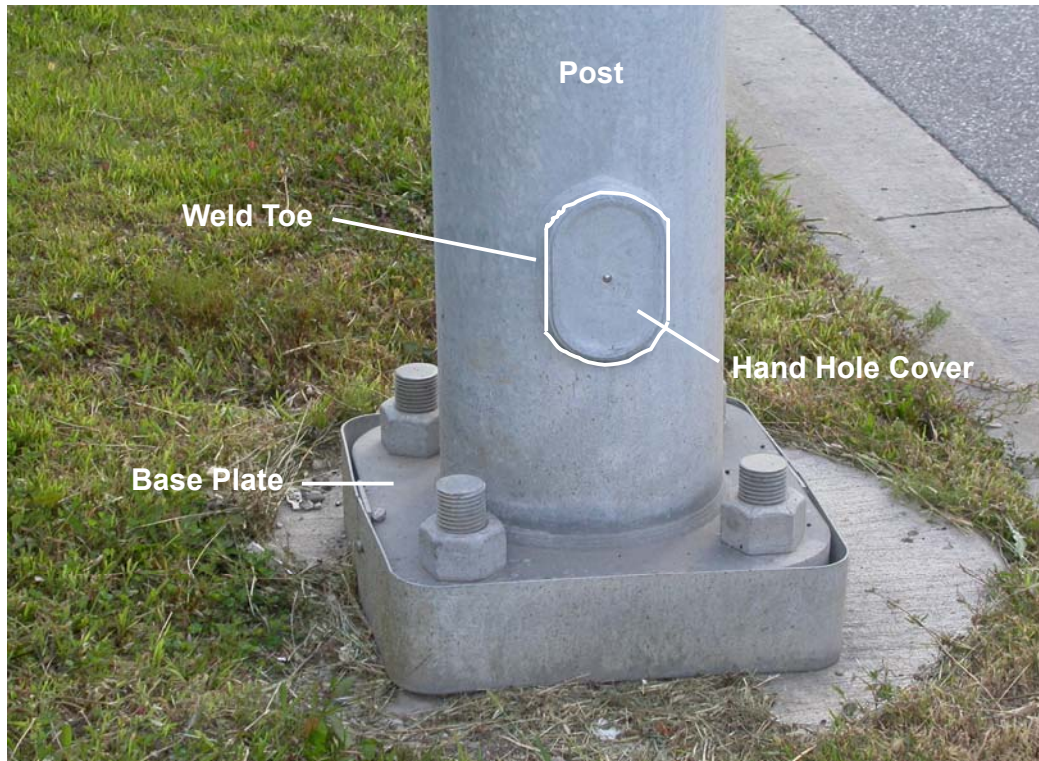


Fig. 17: Hand hole of a single mastarm cantilever sign structure.

Check hand hole for:

- Cracks along weld toe around hand hole
- Corrosion on hand hole
- Corrosion of weld around hand hole
- Missing hand hole cover

Single Mastarm Cantilever Sign Structure

Mastarm-to-post Bolted Connection

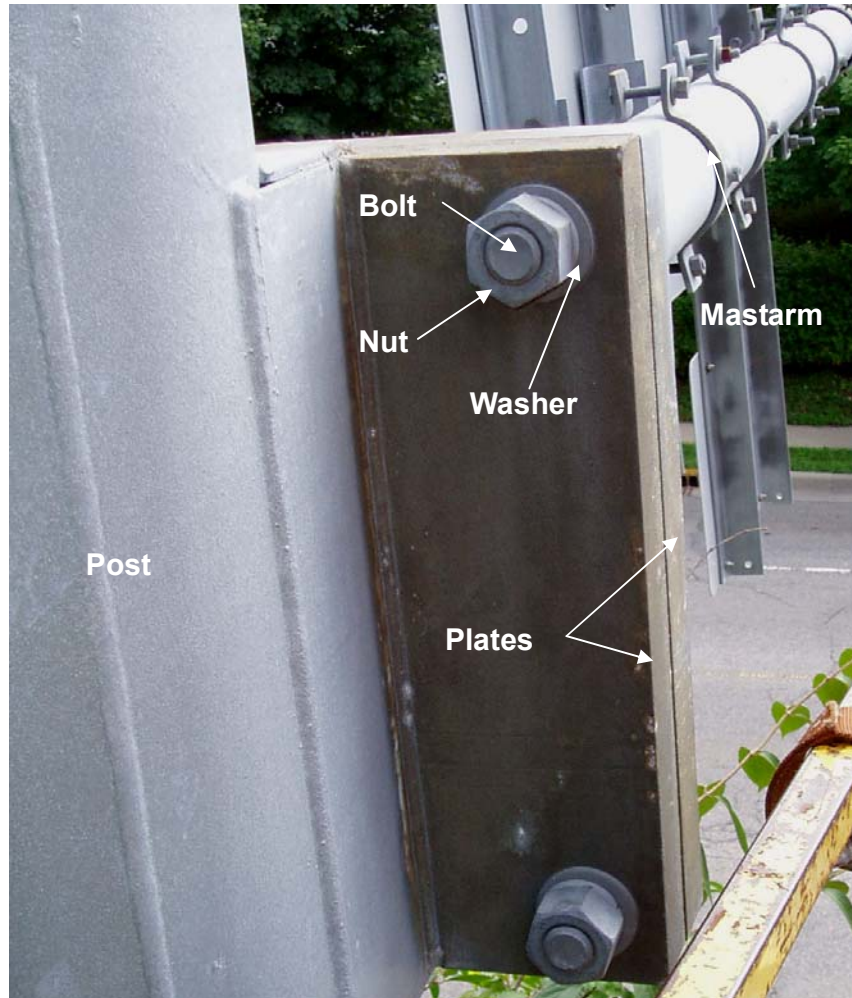


Fig. 18: Mastarm-to-post bolted connection for a single mastarm cantilever sign structure.

Check mastarm-to-post bolted connection for:

- Missing nuts or washers
- Tightness of nuts (tap washer with a hammer)
- Condition of bolt by sounding (tap bolt on the top – dull sound indicates fracture in bolt)
- Corrosion on bolt, nut, and washer

Single Mastarm Cantilever Sign Structure

Built-up Box

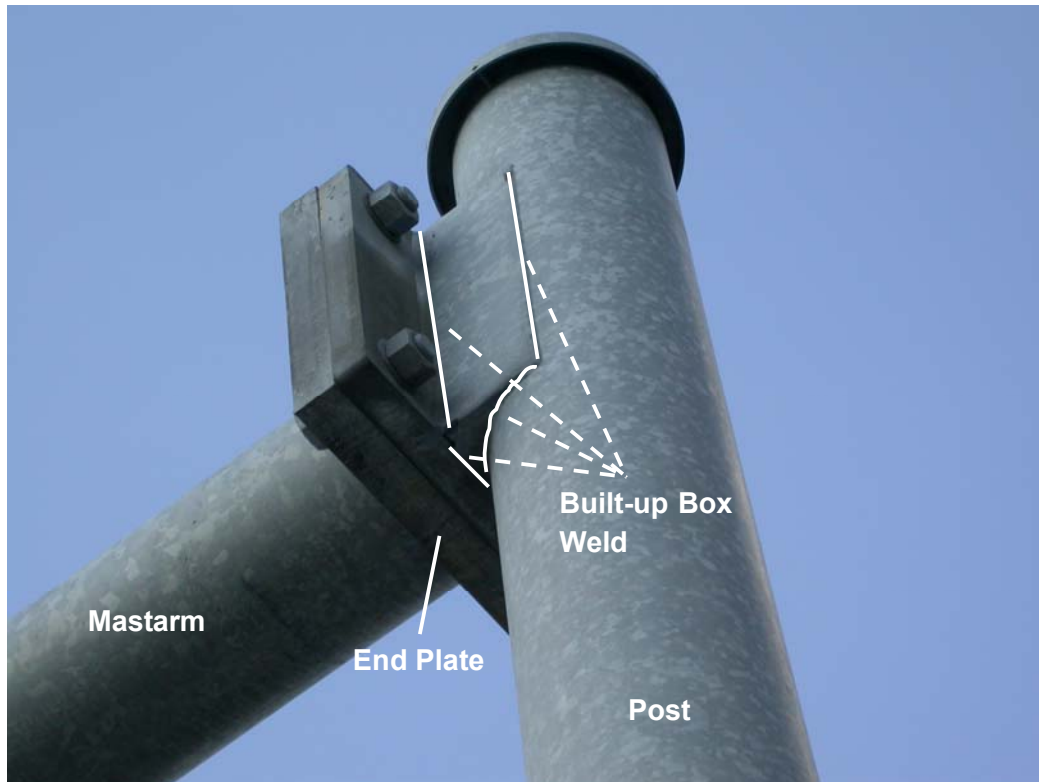


Fig. 19: Built-up box of a single mastarm cantilever sign structure.

Check built-up box for:

- Cracks and irregularities along weld toes
- Corrosion on surfaces of built-up box
- Corrosion of welds

Check plate for:

- Cracks around bolt holes
- Signs of corrosion between plates

Single Mastarm Cantilever Sign Structure

Mastarm-to-End-Plate Weld Connection

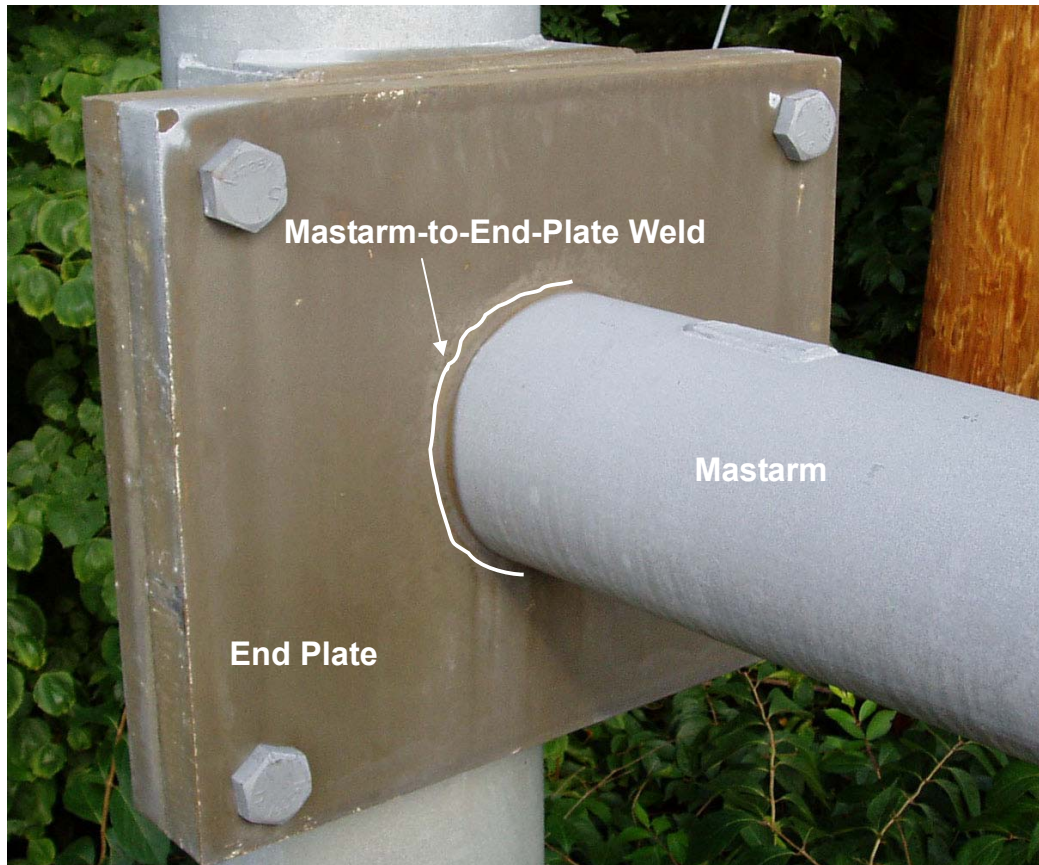


Fig. 20: Mastarm-to-end-plate weld connection for a single mastarm cantilever sign structure.

Check mastarm-to-end-plate weld connection for:

- Cracks and irregularities along weld toes
- Corrosion of weld

Check end plate for:

- Cracks around bolt holes
- Signs of corrosion between plates

Single Mastarm Cantilever Sign Structure

Sign-Panel-to-Mastarm Clamp Connection

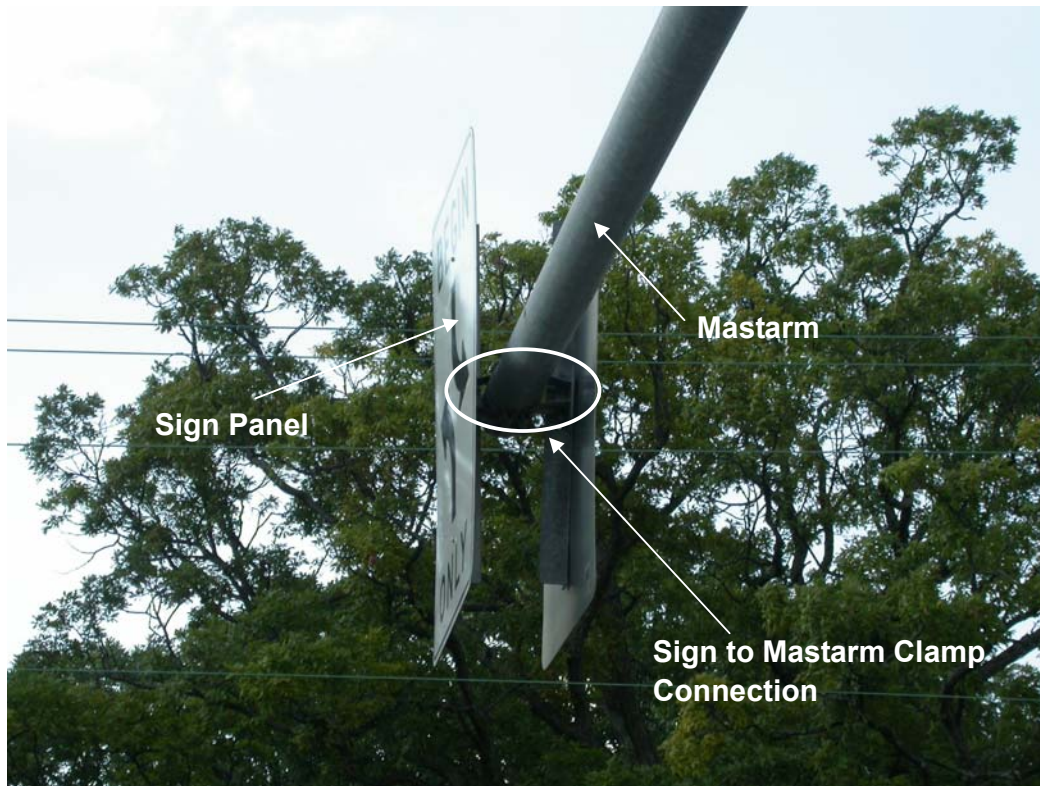


Fig. 21: Sign-panel-to-mastarm clamp connection for a single mastarm cantilever sign structure.

Check sign-panel-to-mastarm clamp connection for:

- Missing nuts or washers
- Tightness of nuts (hand check)
- Corrosion on bolts and clamps

2.5.3 Box-truss Sign Structure

The box-truss sign structure consists of a welded three-dimensional space frame simply supported at each end by a two-post support frame. Fig. 21 shows an aluminum box-truss sign structure and the locations of several important details, including the base plate connection, hand hole, chord to support frame connection, trusses and chords.

The following is an introduction of what should be inspected for each critical detail in the box-truss sign structure.

Box-truss Sign Structure

Overall View



Fig. 22: Box-truss sign structure.

Take a look at overall condition of structure. Make note of the following:

- Overall corrosion
- Abnormal global deformation of foundation, support frame and truss frame
- Clearance between truss frame and roadway surface
- Looseness of U-bolt bracket connections for the walkway and signs

Box-truss Sign Structure

Foundation

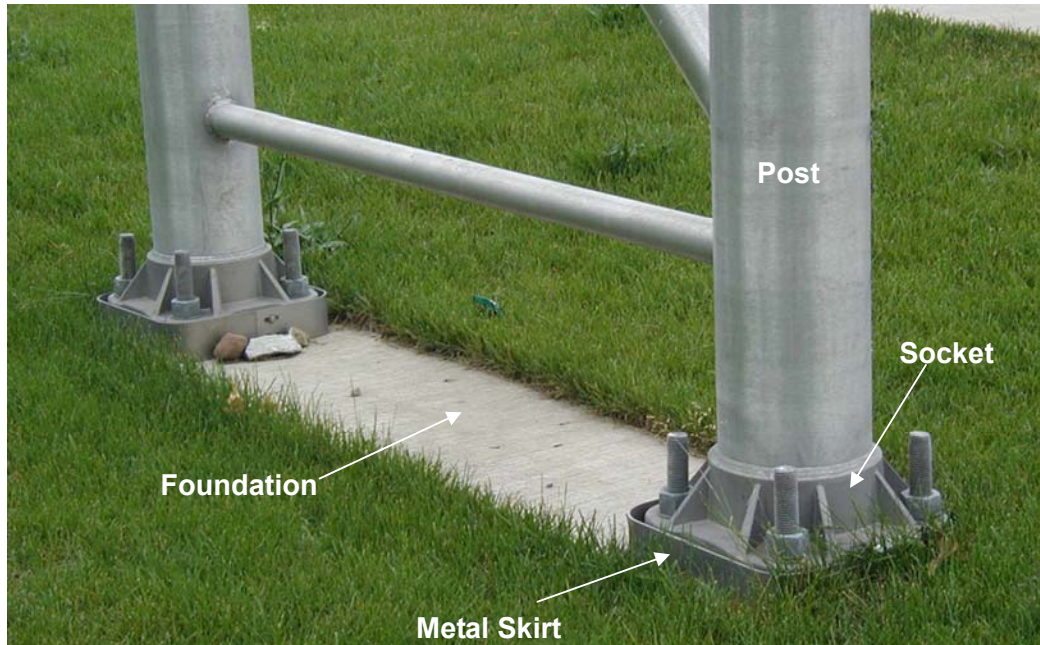


Fig. 23: Foundation of a box-truss sign structure.

Remove metal skirt and check foundation for:

- Debris accumulation
- Impact damage, spalling, scaling and surface cracking (especially around anchor rods)
- Sub-surface crack (sound with a hammer – dull sound indicates existence of cracking)

Box-truss Sign Structure

Anchor Rods

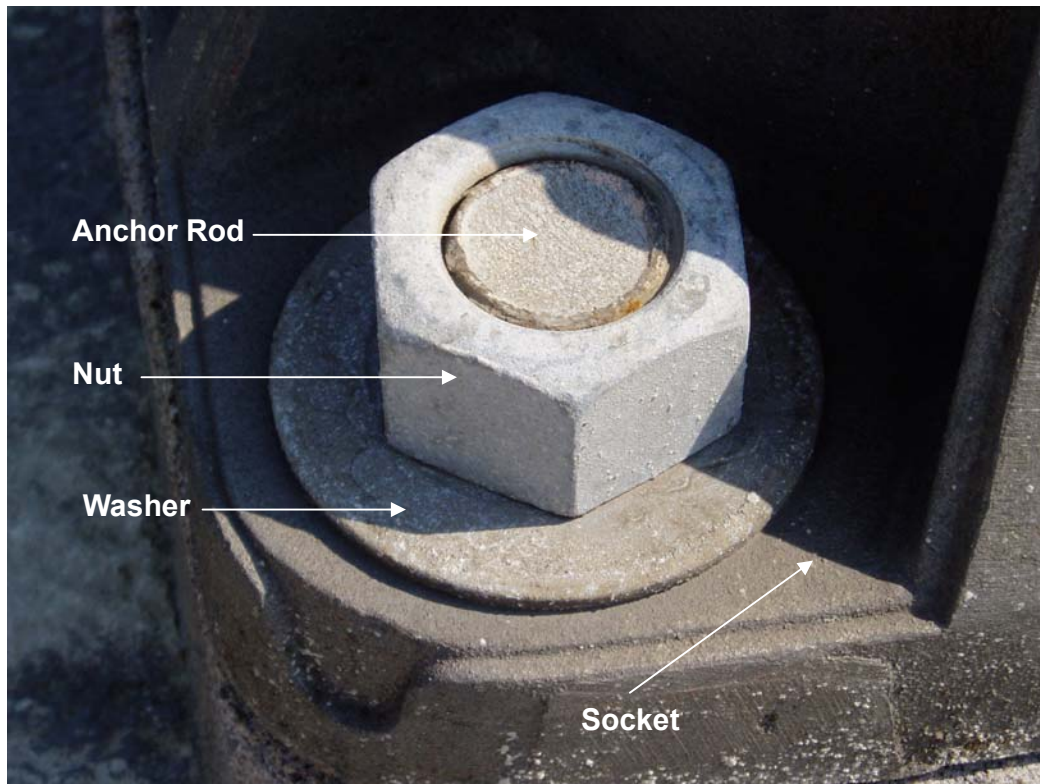


Fig. 24: Anchor rods detail of a box-truss sign structure.

Remove metal skirt and check anchor rods for:

- Missing nuts or washers
- Tightness of nuts (tap washer with a hammer)
- Condition of anchor rod by sounding (tap anchor rod on the top – dull sound indicates possible fracture in anchor rod)
- Thread damage in anchor rod if accessible (especially first thread under bottom nut if accessible)
- Corrosion on surfaces of anchor rod, nut and washer

Box-truss Sign Structure

Post-to-Socket Weld Connection

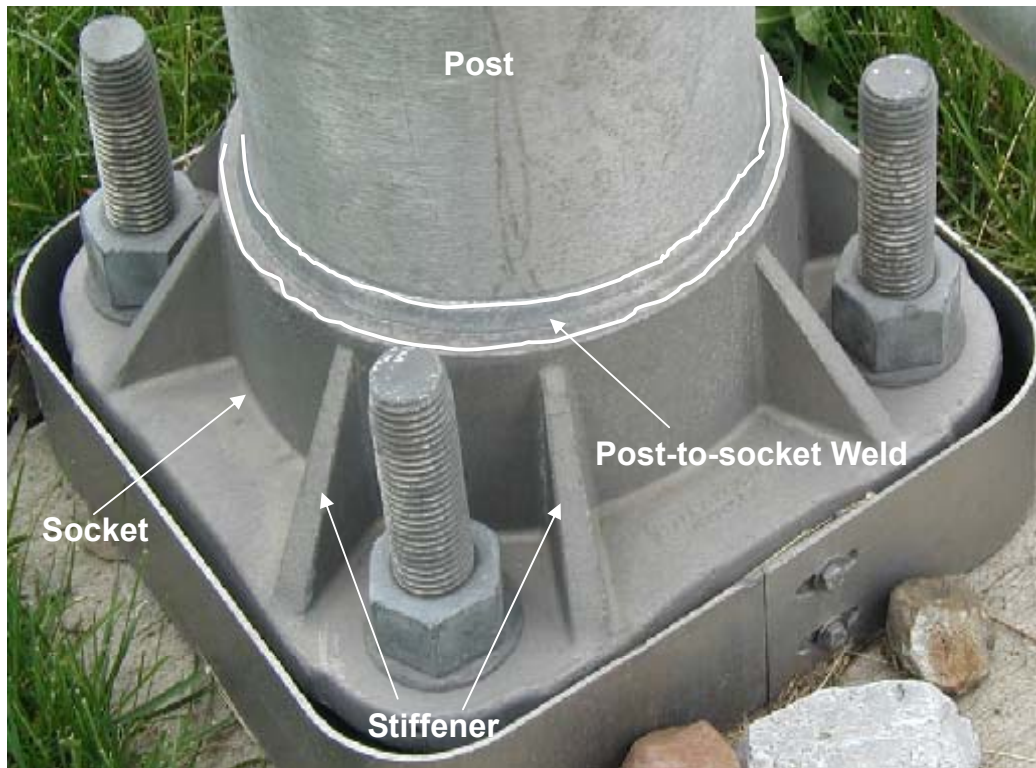


Fig. 25: Post-to-socket weld connection for a box-truss sign structure.

Check post-to-socket weld for:

- Cracks and irregularities along weld toes
- Corrosion of weld

Check socket for:

- Corrosion on surface
- Cracks at tip of stiffeners or around holes
- Levelness

Box-truss Sign Structure

Support Post

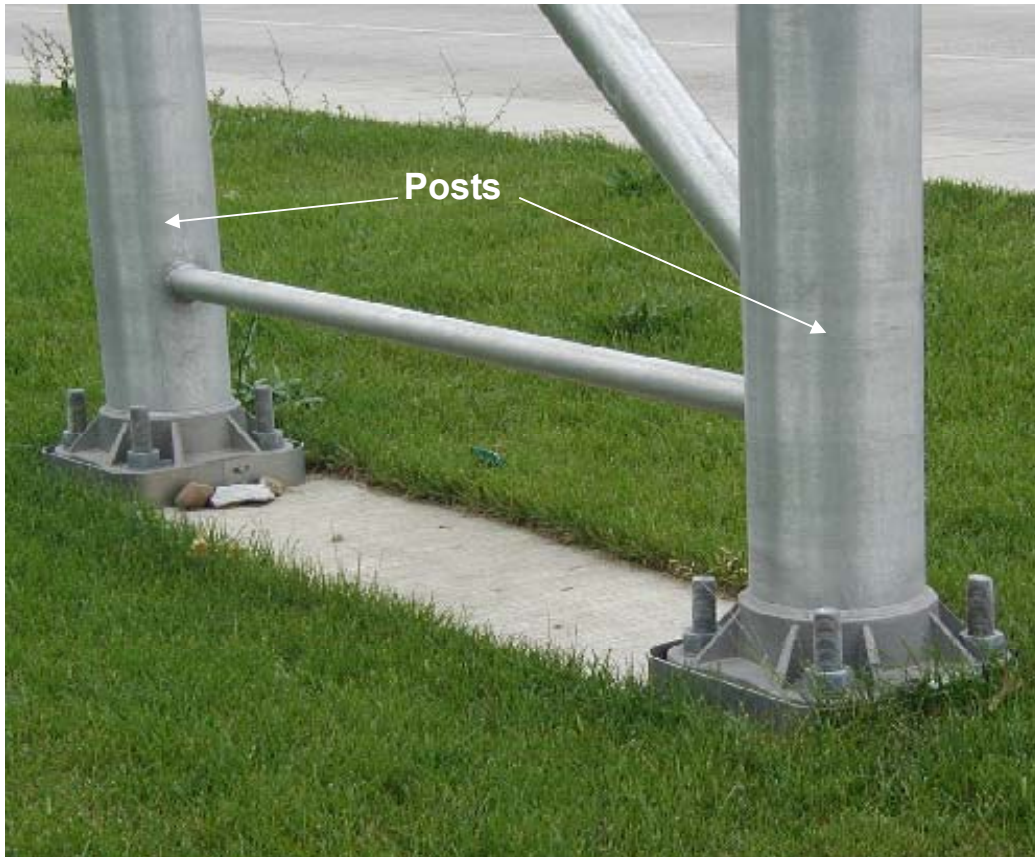


Fig. 26: Support post of a box-truss sign structure.

Check post for:

- Coverage of galvanized coating and existence of any rust on post (sound rusted area with a hammer to identify any weakened sections)
- Signs of internal corrosion (sound lower part of post – dull sound indicates corrosion)

Box-truss Sign Structure

Hand Hole



Fig. 27: Hand hole of a box-truss sign structure.

Check hand hole for:

- Cracks at weld toe around hand hole
- Corrosion on hand hole
- Missing hand hole cover
- Corrosion of welds around hand hole

Box-truss Sign Structure

Brace-to-post Weld Connection

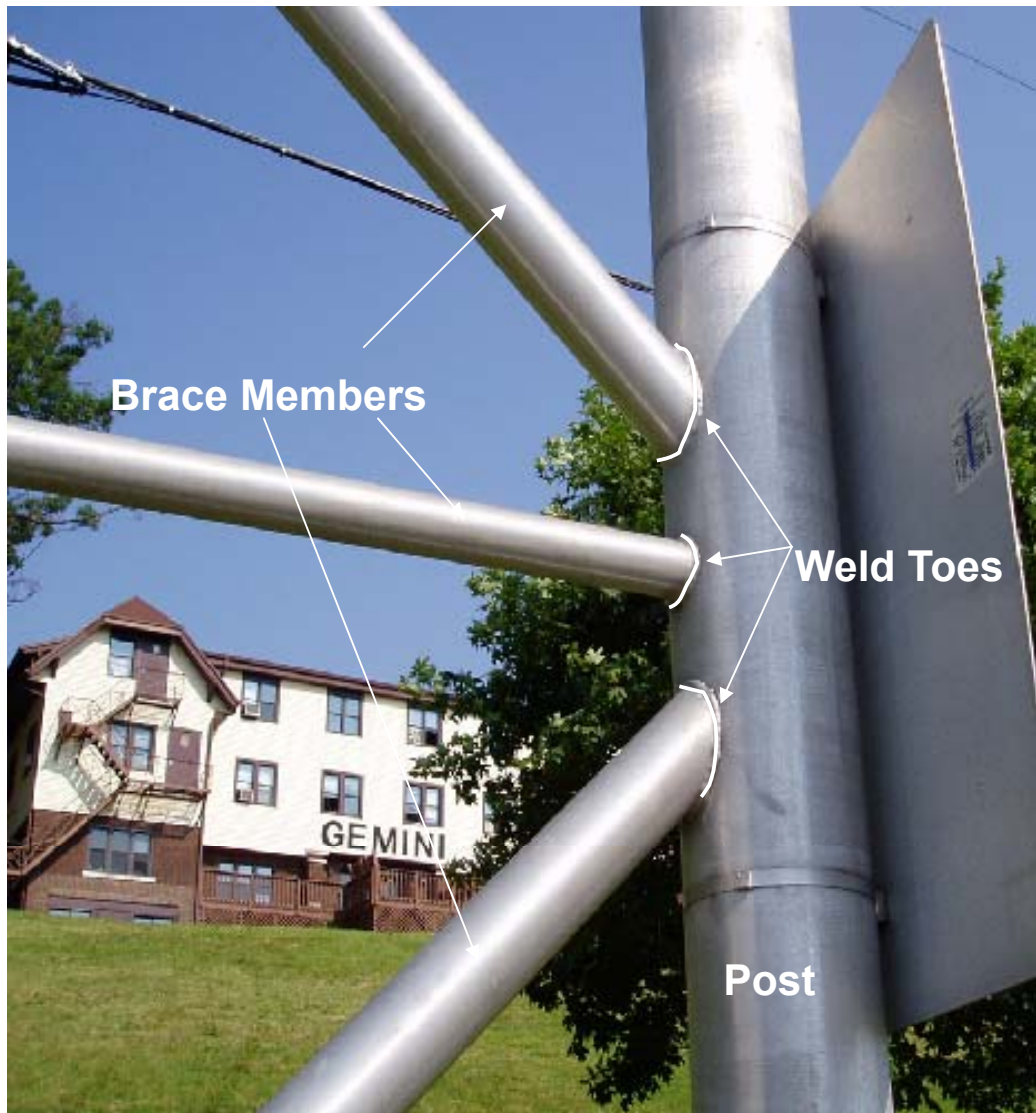


Fig. 28: Brace-to-post weld connection for a box-truss sign structure.

Check brace-to-post weld connection for:

- Cracks and irregularities along weld toes
- Corrosion of welds

Box-truss Sign Structure

Upper Chord-to-Support-Post Connection

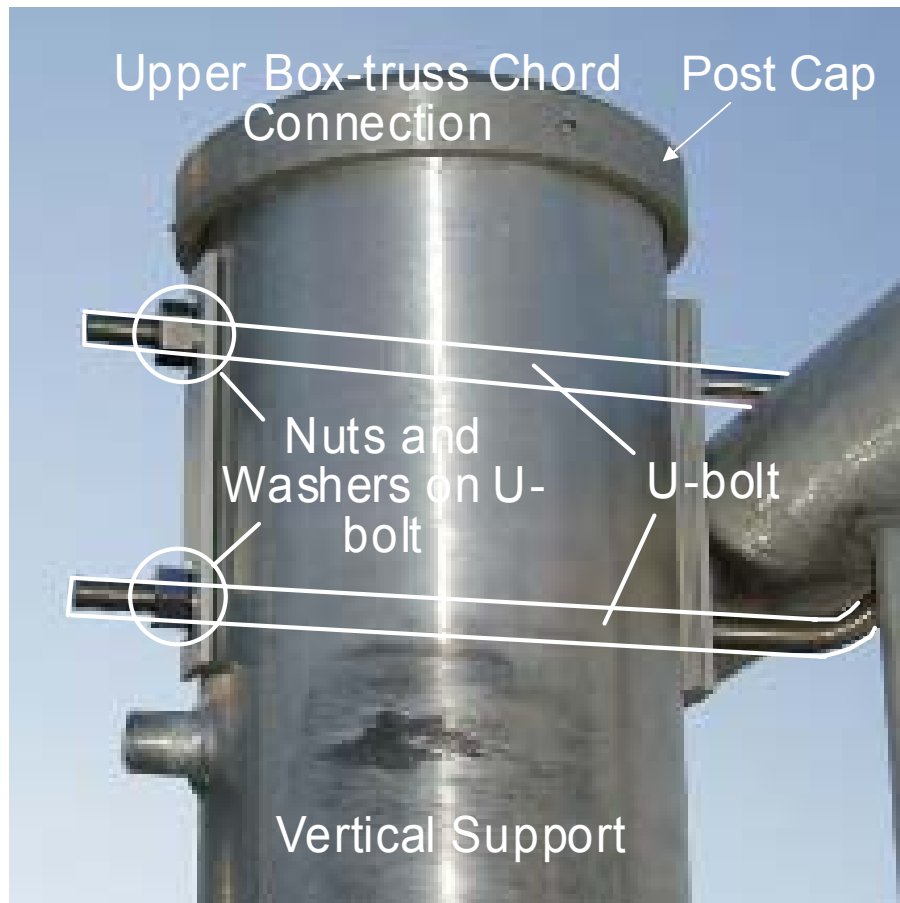


Fig. 29: Upper chord-to-support-post connection for a box-truss sign structure.

Check upper chord-to-support-post connection for:

- Snugness of U-bolts around chord
- Tightness of nuts (tap washers with a hammer)
- Missing nuts or washers
- Corrosion on components
- Presence of post cap

Box-truss Sign Structure

Lower Chord-to-crossbar Connection

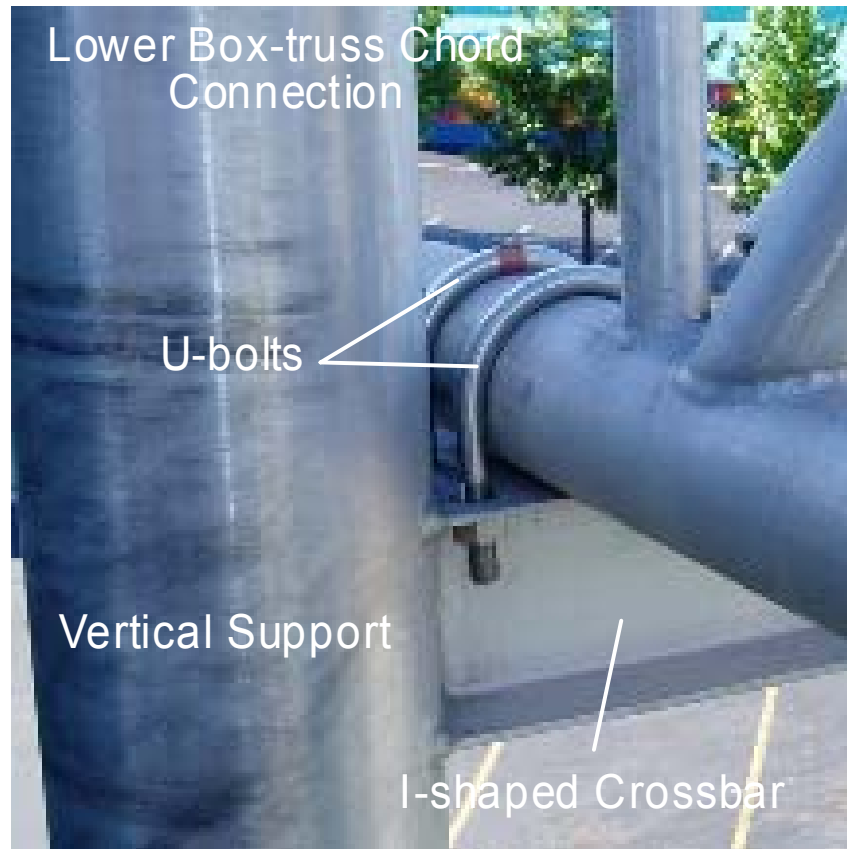


Fig. 30: Lower chord –to-crossbar connection for a box-truss sign structure.

Check lower chord-to-crossbar connection for:

- Snugness of U-bolts around chord
- Tightness of nuts (tap washers with a hammer)
- Missing nuts or washers
- Corrosion on components

Box-truss Sign Structure

Crossbar-to-Support Weld Connection

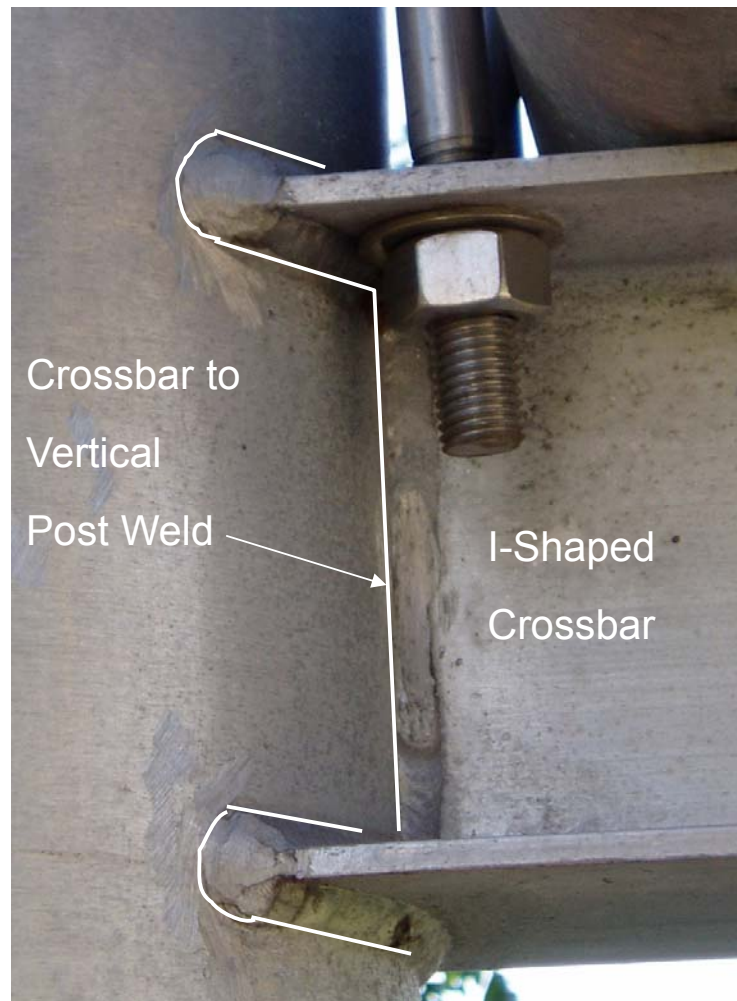


Fig. 31: Crossbar-to-support weld connection for a box-truss sign structure.

Check crossbar-to-support weld connection for:

- Cracks and irregularities along weld toes
- Corrosion of welds

Box-truss Sign Structure

Chord Splice Connection

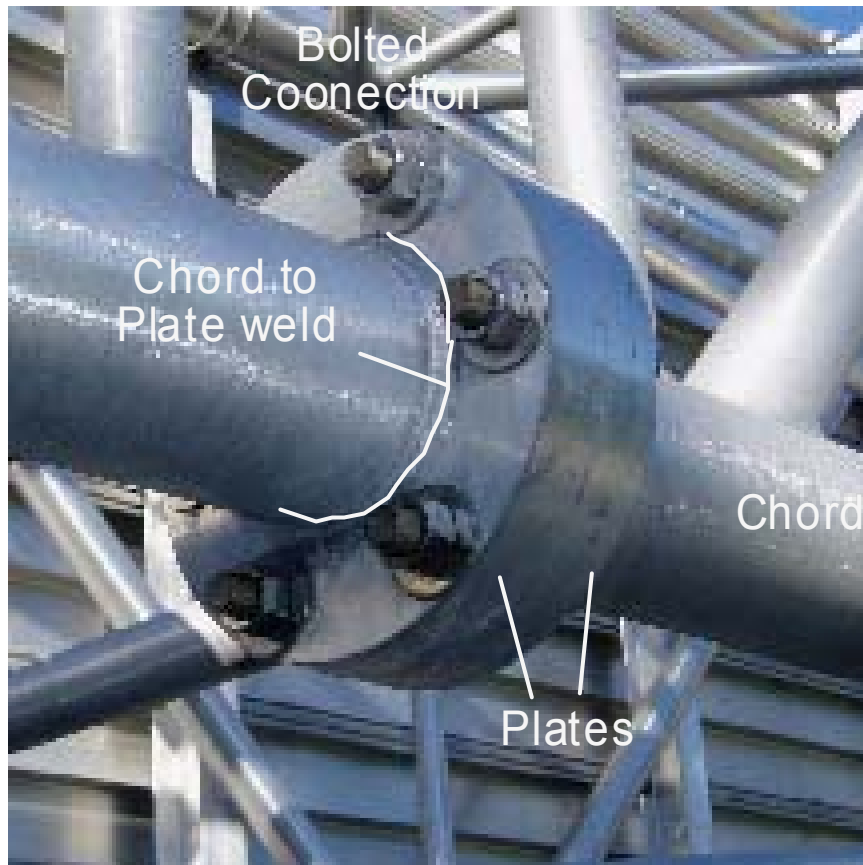


Fig. 32: Chord splice connection for a box-truss sign structure.

Check chord splice connection for:

- Cracks and irregularities along weld toes
- Corrosion of welds
- Missing nuts or washers
- Tightness of nuts (tap washer with a hammer)
- Condition of bolt by sounding (tap bolt on the top – dull sound indicates possible fracture in bolt)
- Cracks around bolt holes
- Corrosion on surfaces of bolt, nut, washer, and plates
- Signs of corrosion between plates

Box-truss Sign Structure

Truss-Member-to-Chord Weld Connection

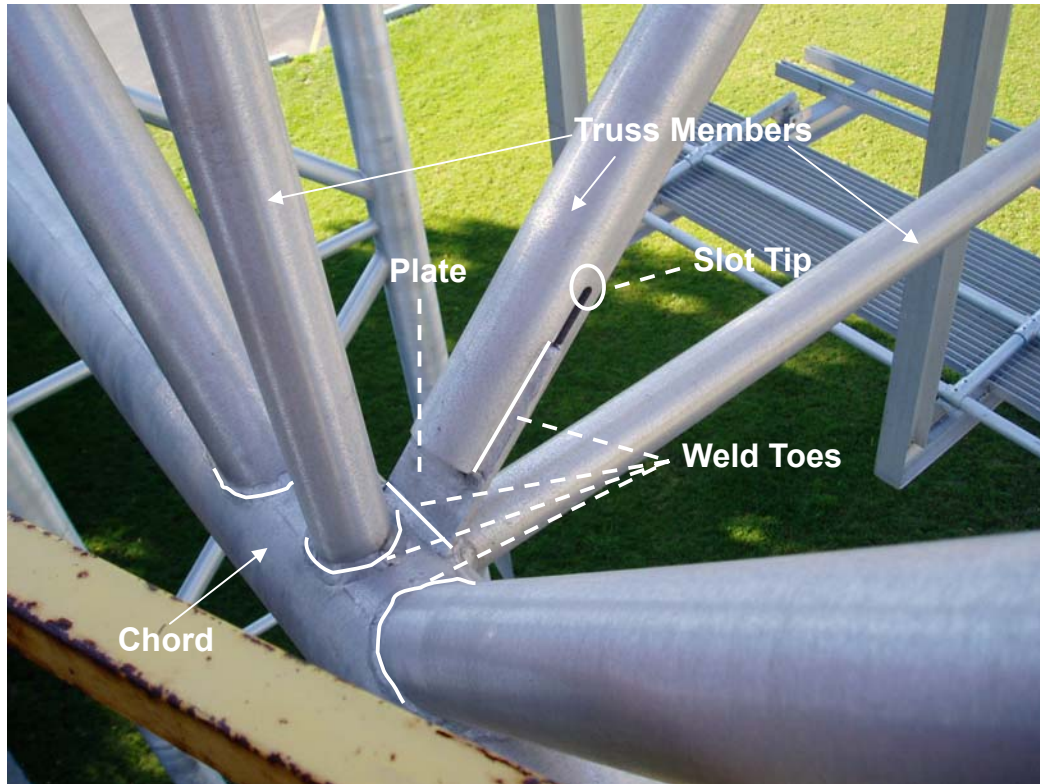


Fig. 33: Truss-member-to-chord weld connection for a box-truss sign structure.

Check truss-member-to-chord weld connection for:

- Cracks and irregularities at weld toes
- Cracks at slot tips
- Corrosion of welds, truss members and chords

2.5.4 Monotube Sign Structure

The monotube sign structure consists of a horizontal chord supported by a steel post at each end. A monotube sign structure and the locations of several important structural details are shown in Fig. 33. For the monotube, a pipe member is placed between two tapered members. For each tapered member, the end with smaller diameter is placed at end of the span. The sign panels are attached to the chord with clamps.

The following is an explanation of what should be inspected for each detail in the monotube sign structure.

Monotube Sign Structure

Overall View

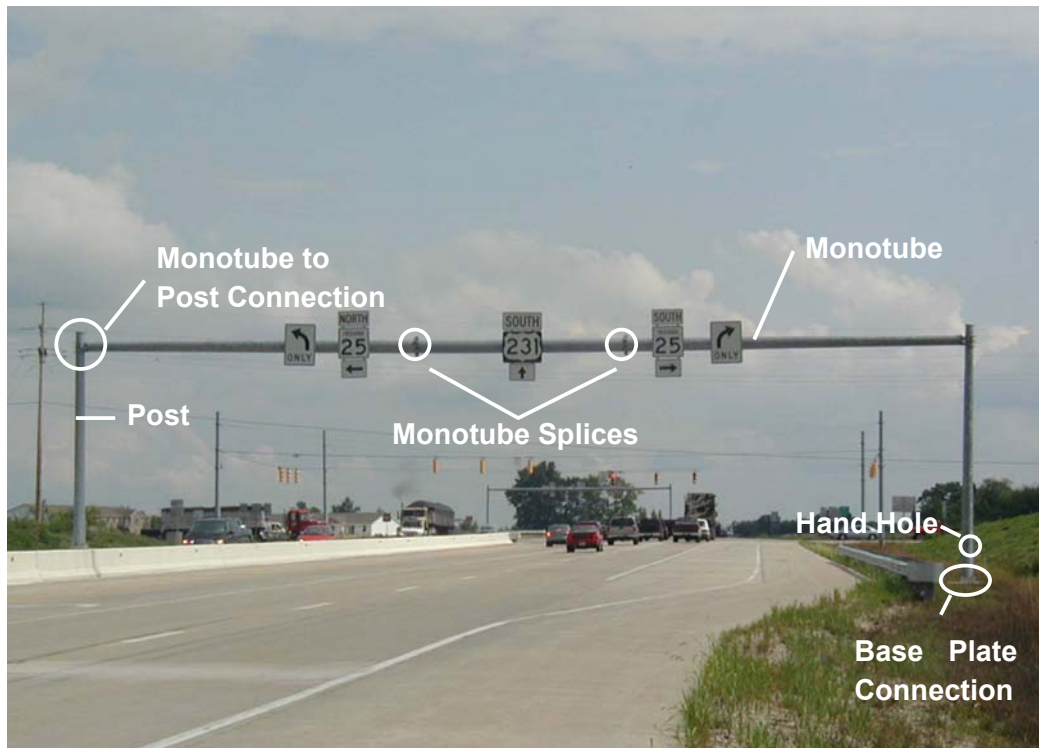


Fig. 34: Monotube sign structure.

Take a look at overall condition of structure. Make note of the following:

- Overall corrosion
- Abnormal global deformation of foundation, posts and monotube
- Clearance between monotube and roadway surface

Monotube Sign Structure

Foundation

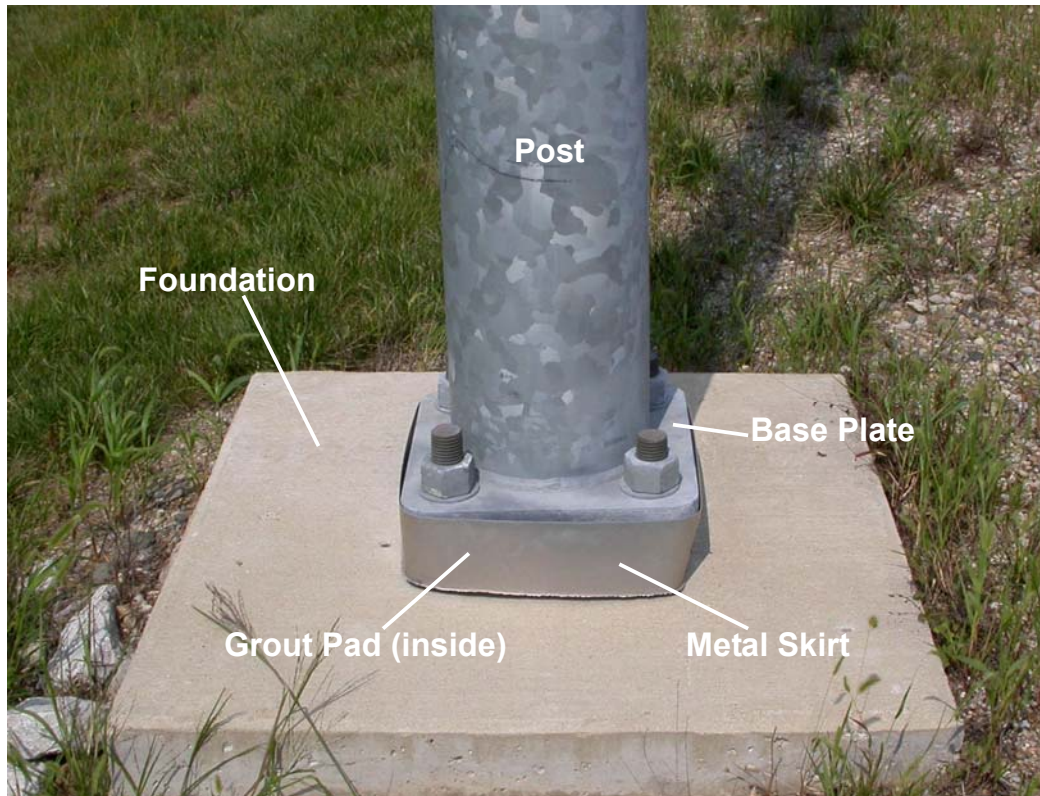


Fig. 35: Foundation of a monotube sign structure.

Remove metal skirt and check foundation for:

- Debris accumulation
- Impact damage, spalling, scaling and surface cracking (especially around anchor rods)
- Sub-surface crack (sound with a hammer – dull sound indicates existence of cracking)

Check base plate for:

- Corrosion on surface
- Cracks at the edge or around holes
- Levelness

Monotube Sign Structure

Anchor Rods

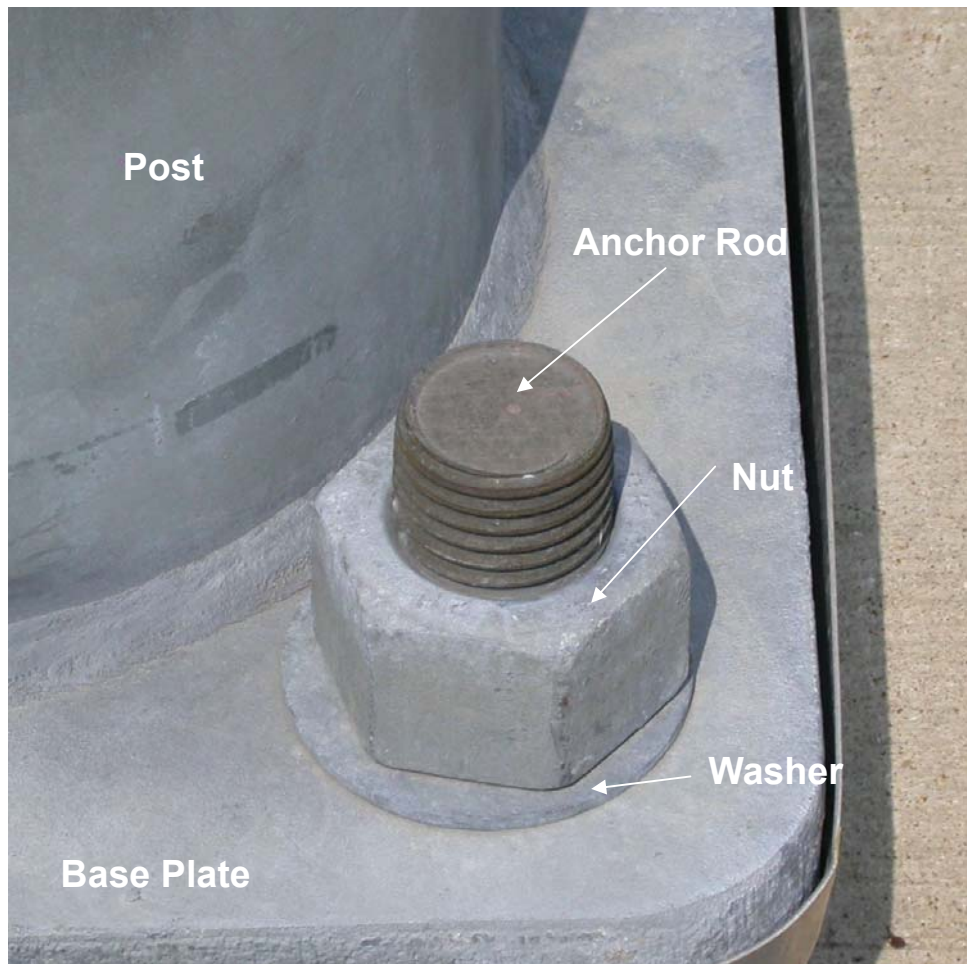


Fig. 36: Anchor rods detail of a monotube sign structure.

Remove metal skirt and check anchor rods for:

- Missing nuts
- Tightness of nuts (tap nuts with a hammer)
- Condition of anchor rod by sounding (tap anchor rod on the top – dull sound indicates possible fracture in anchor rod)
- Thread damage in anchor rod (especially first thread under bottom nut if accessible)
- Corrosion on surfaces of anchor rod, and nuts

Monotube Sign Structure

Post-to-Base-Plate Weld Connection

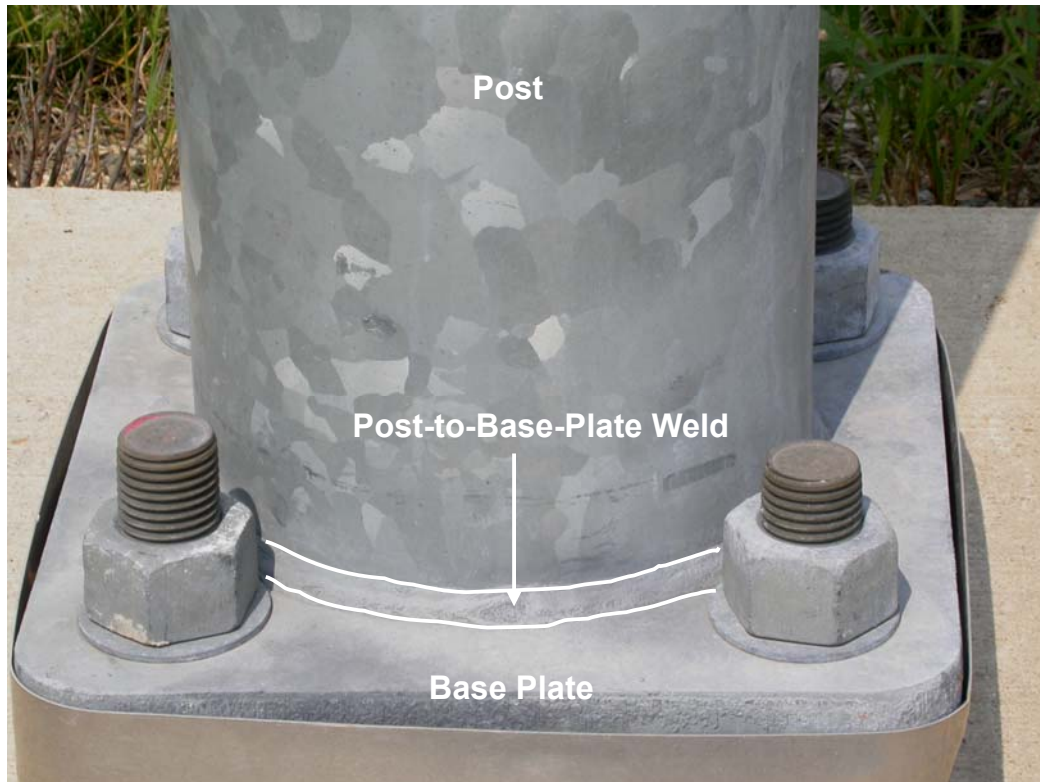


Fig. 37: Post-to-base-plate weld detail of a monotube sign structure.

Check post-to-base-plate weld for:

- Cracks and irregularities in weld
- Corrosion of weld

Monotube Sign Structure

Support Post



Fig. 38: Support post of a monotube sign structure.

Check post for:

- Coverage of galvanized coating and existence of any rust on post (sound rusted area with a hammer to identify any weakened sections)
- Signs of internal corrosion (sound lower part of post – dull sound indicates corrosion)

Monotube Sign Structure

Hand Hole



Fig. 39: Hand Hole of a monotube sign structure.

Check hand hole for:

- Cracks along weld toe around hand hole
- Corrosion on hand hole
- Missing hand hole cover
- Corrosion of weld around hand hole

Monotube Sign Structure

Span-to-Post Clamp Connection

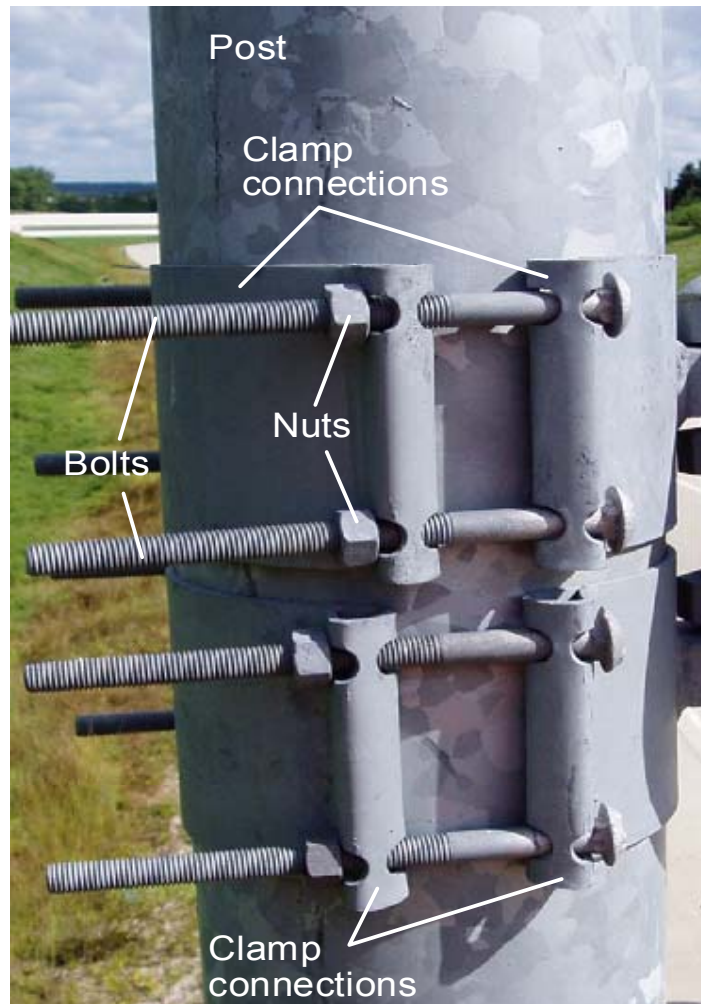


Fig. 40: Span-to-post clamp connection for a monotube sign structure.

Check span-to-post clamp connection for:

- Missing nuts
- Tightness of nuts (hand check)
- Fractured or damaged threads of bolts
- Corrosion on bolts and clamps

Monotube Sign Structure

Monotube-to-Post Pin Connection

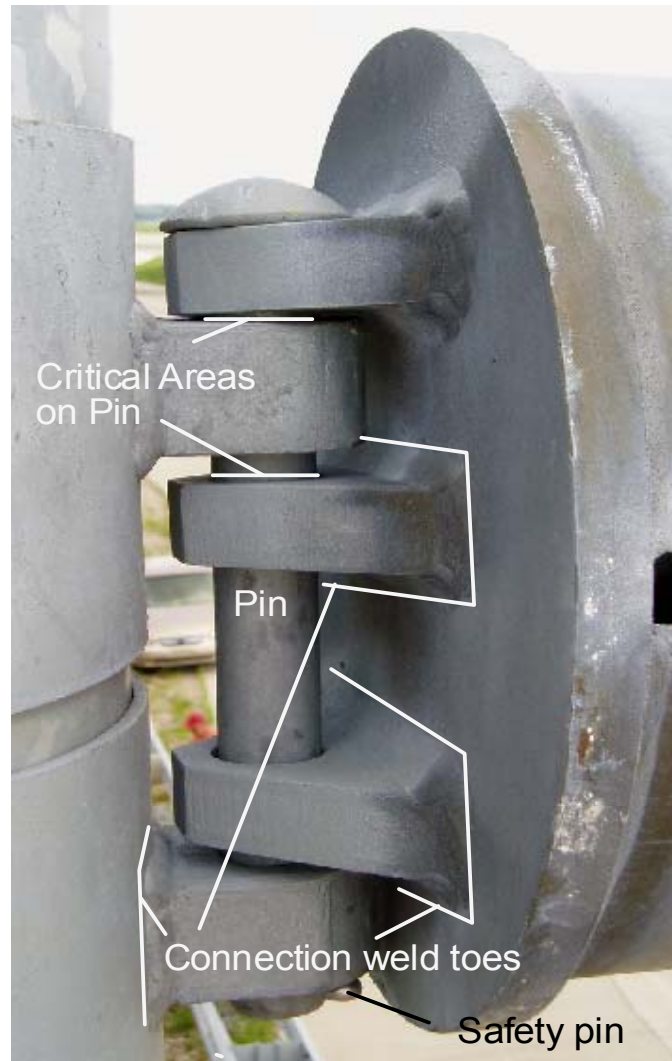


Fig. 41: Monotube-to-post pin connection for a monotube sign structure.

Check monotube-to-post pin connection for:

- Cracks and irregularities along weld toes
- Cracks at critical areas on pin
- Corrosion or deformation of pin
- Safety pin in place
- Corrosion of safety pin
- Corrosion of welds

Monotube Sign Structure

Monotube-to-End-Plate Weld Connection

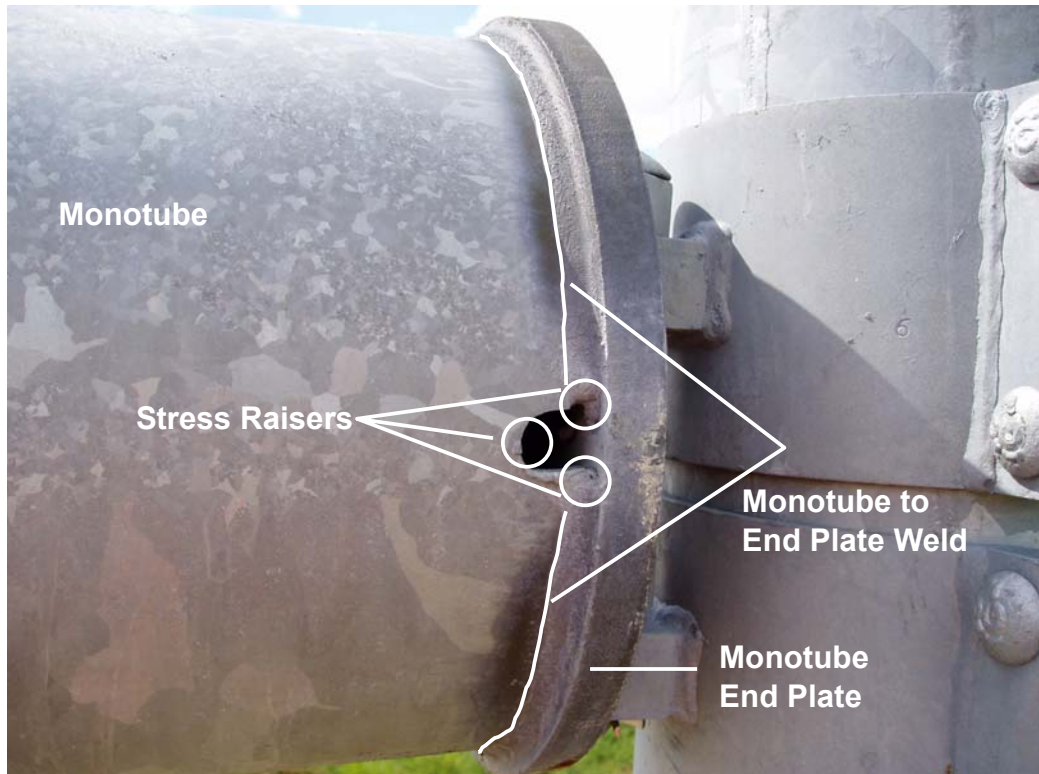


Fig. 42: Monotube-to-end-plate weld connection for a monotube sign structure.

Check monotube-to-end-plate weld connection for:

- Cracks and irregularities along weld toes
- Cracks at stress raisers
- Corrosion of welds

Monotube Sign Structure

Monotube Splice Connection

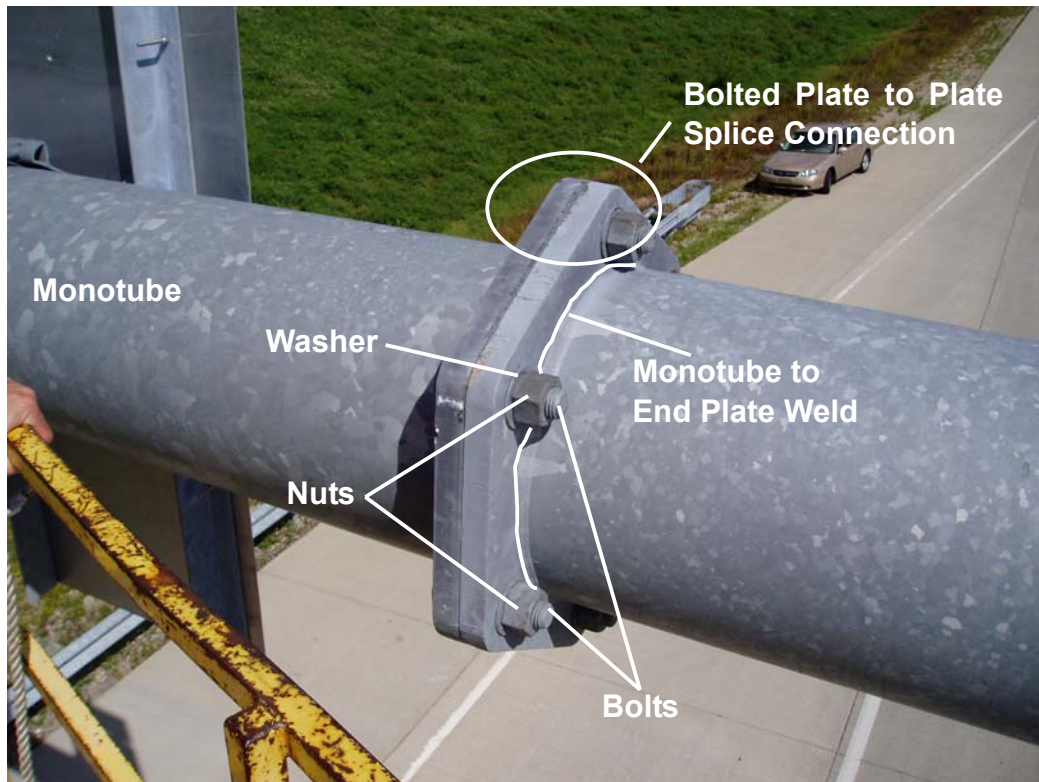


Fig. 43: Monotube splice connection for a monotube sign structure.

Check monotube splice connection for:

- Cracks and irregularities along weld toes
- Missing nuts or washers
- Tightness of nuts (tap washer with a hammer)
- Condition of bolt by sounding (tap bolt on the top – dull sound indicates possible fracture in bolt)
- Cracks around bolt holes
- Corrosion of welds
- Corrosion on surfaces of bolt, nut, and washer
- Signs of corrosion between end plates

Monotube Sign Structure

Sign-to-Monotube Clamp Connection

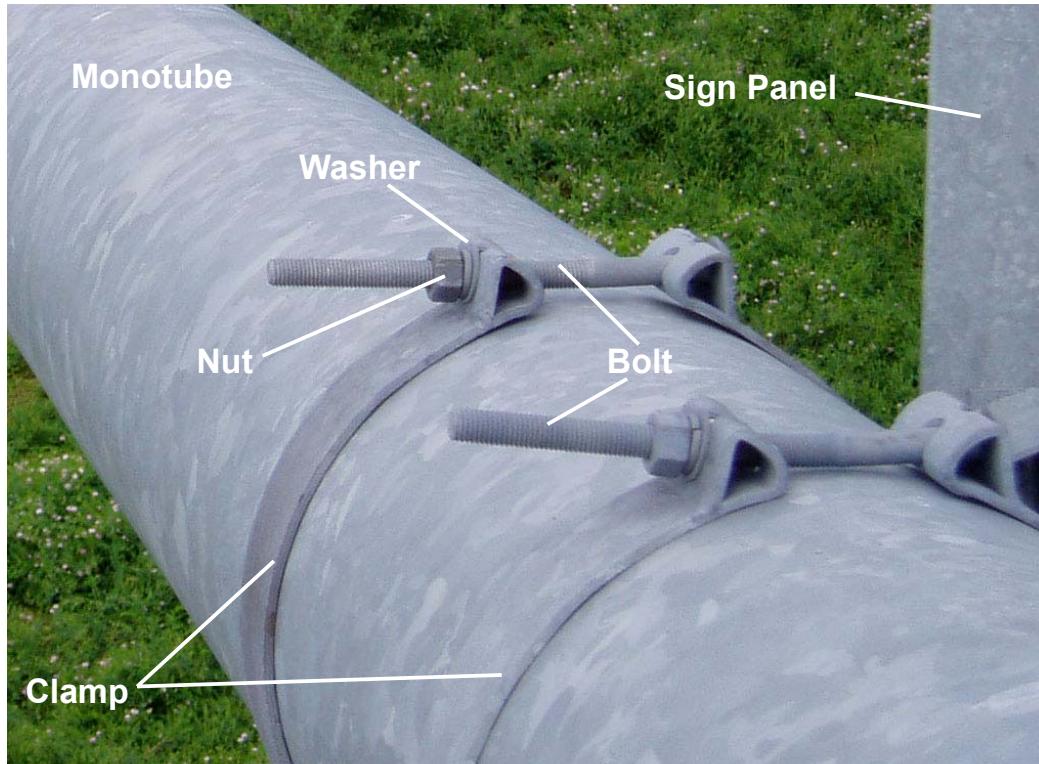


Fig. 44: Sign-to-monotube clamp connection for a monotube sign structure.

Check sign-to-monotube clamp connection for:

- Missing nuts or washers
- Tightness of nuts (hand check)
- Fractured or damaged threads of bolts
- Corrosion of bolts and clamps

2.5.5 Tri-chord Sign Structure

The tri-chord sign structure consists of a welded three-dimensional space frame simply supported at each end by a post. There are three chords in the space frame. Fig. 44 shows a tri-chord sign structure and the locations of several important details including base plate connection, hand hole, chord to post simply supported connection, and space frame.

The following is an introduction of what should be inspected for each detail in the tri-chord sign structure.

Tri-chord Sign Structure

Overall View



Fig. 45: Tri-chord sign structure.

Take a look at overall condition of structure. Make note of the following:

- Overall corrosion
- Abnormal global deformation of foundation, support post and space frame
- Clearance between space frame and roadway surface

Tri-chord Sign Structure

Foundation

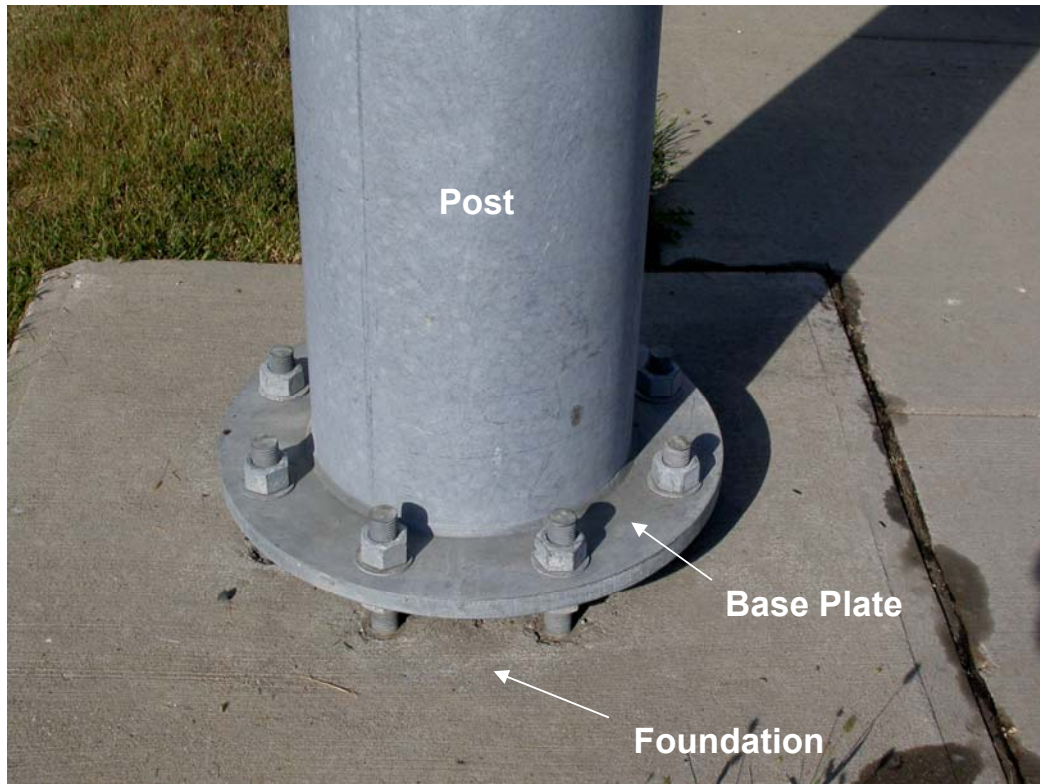


Fig. 46: Foundation of a tri-chord sign structure.

Check foundation for:

- Debris accumulation
- Impact damage, spalling, scaling and surface cracking (especially around anchor rods)
- Sub-surface crack (sound with a hammer – dull sound indicates existence of cracking)

Check base plate for:

- Corrosion on surface
- Cracks at the edge or around holes
- Levelness

Tri-chord Sign Structure

Anchor Rods

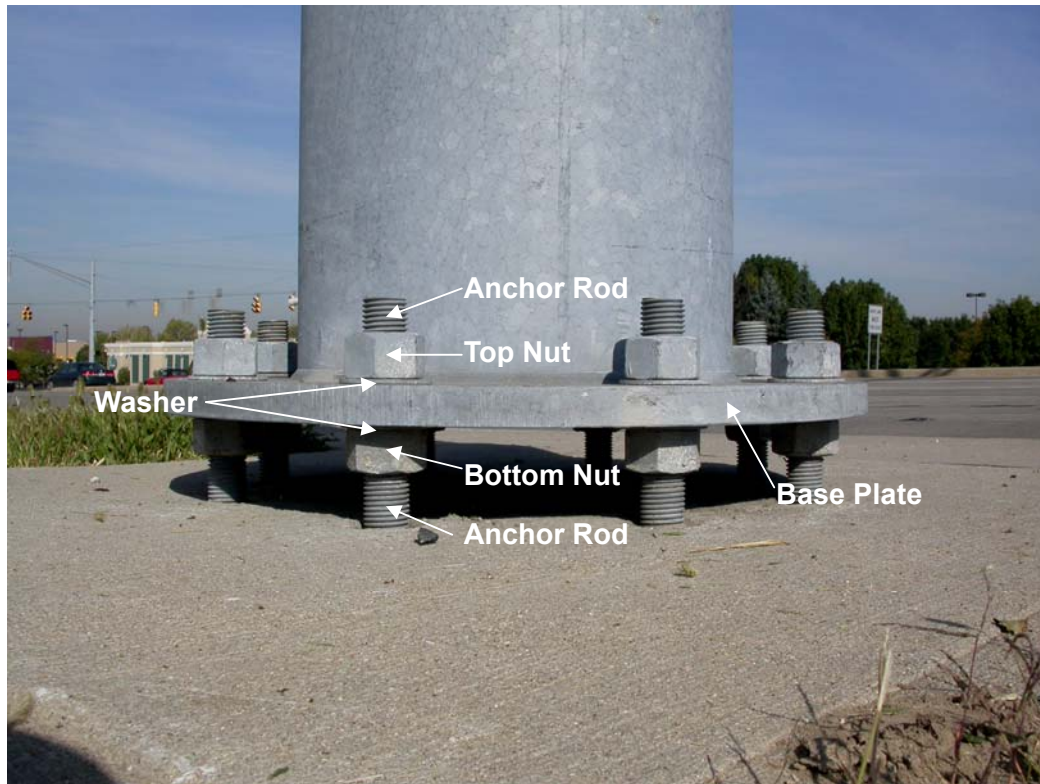


Fig. 47: Anchor rods detail of a tri-chord sign structure.

Check anchor rods for:

- Missing nuts or washers
- Tightness of nuts (tap washer with a hammer)
- Condition of anchor rod by sounding (tap anchor rod on the top – dull sound indicates possible fracture in anchor rod)
- Thread damage in anchor rod (especially first thread under bottom nut if accessible)
- Corrosion on surfaces of anchor rod, nut and washer

Tri-chord Sign Structure

Post-to-Base-Plate Weld Connection

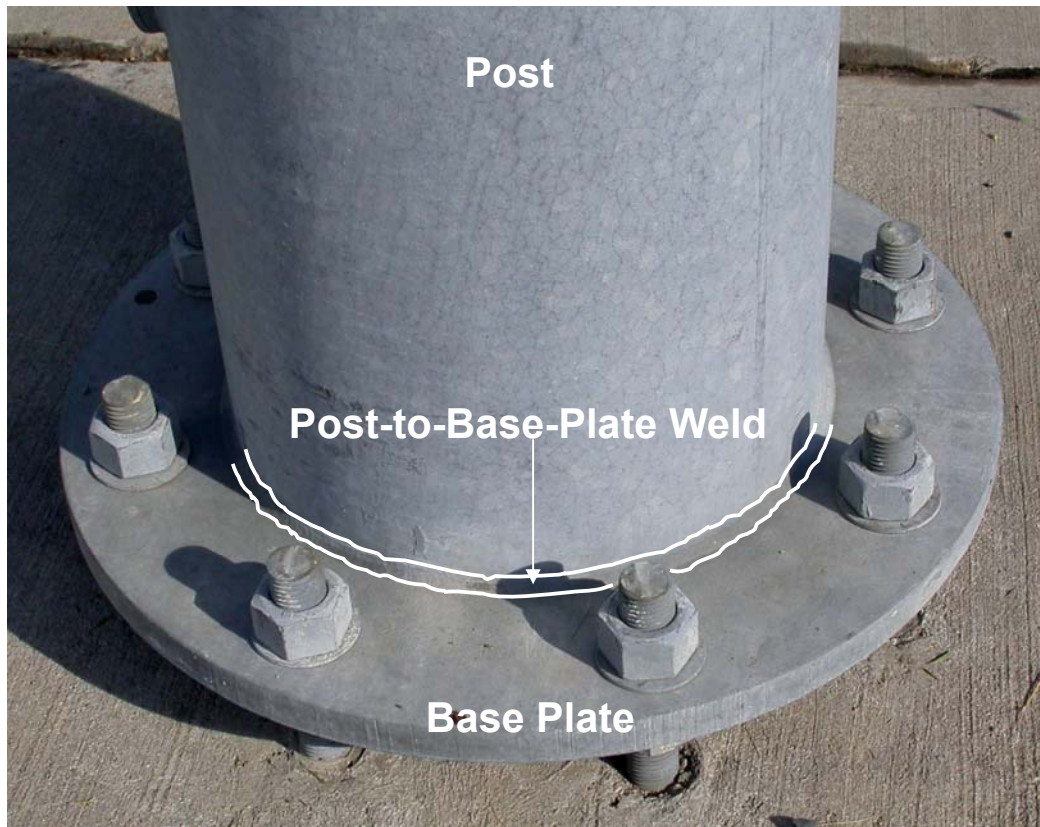


Fig. 48: Post-to-base-plate weld connection for a tri-chord sign structure.

Check post-to-base-plate weld for:

- Cracks and irregularities along weld toes
- Corrosion of weld

Tri-chord Sign Structure

Support Post

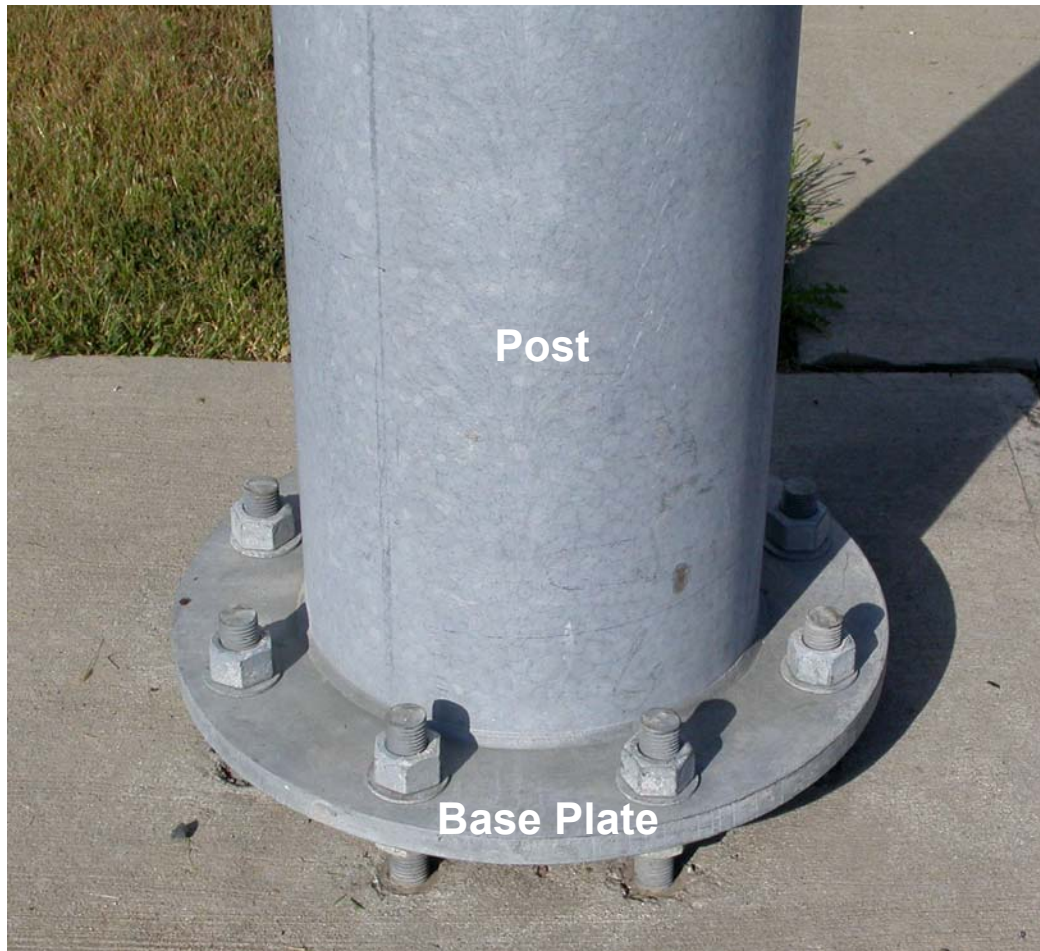


Fig. 49: Support post of a tri-chord sign structure.

Check post for:

- Coverage of galvanized coating and existence of any rust on post (sound rusted area with a hammer to identify any weakened sections)
- Damage on surface caused by collision
- Signs of internal corrosion (sound lower part of post – dull sound indicates corrosion)

Tri-chord Sign Structure

Hand Hole

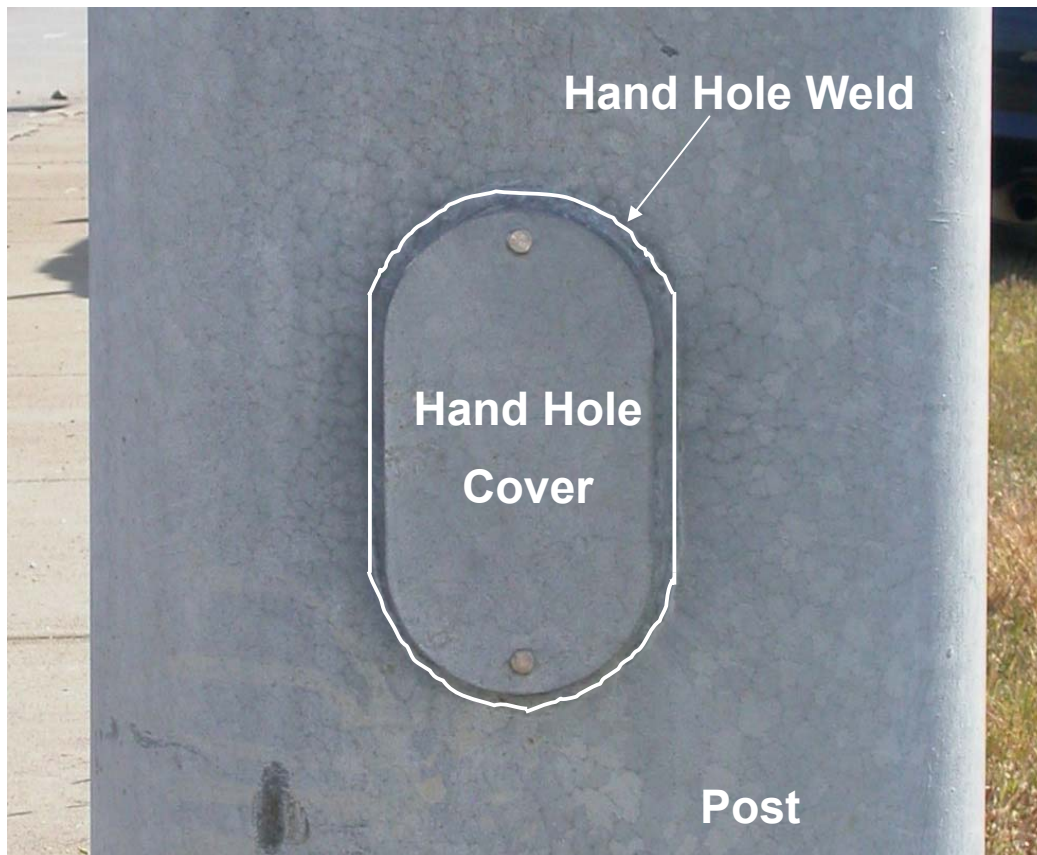


Fig. 50: Hand hole of a tri-chord sign structure.

Check hand hole for:

- Cracks at weld toe around hand hole
- Corrosion of weld around hand hole
- Corrosion of hand hole
- Missing hand hole cover

Tri-chord Sign Structure

Chord-to-Support-Post U-bolt Connection

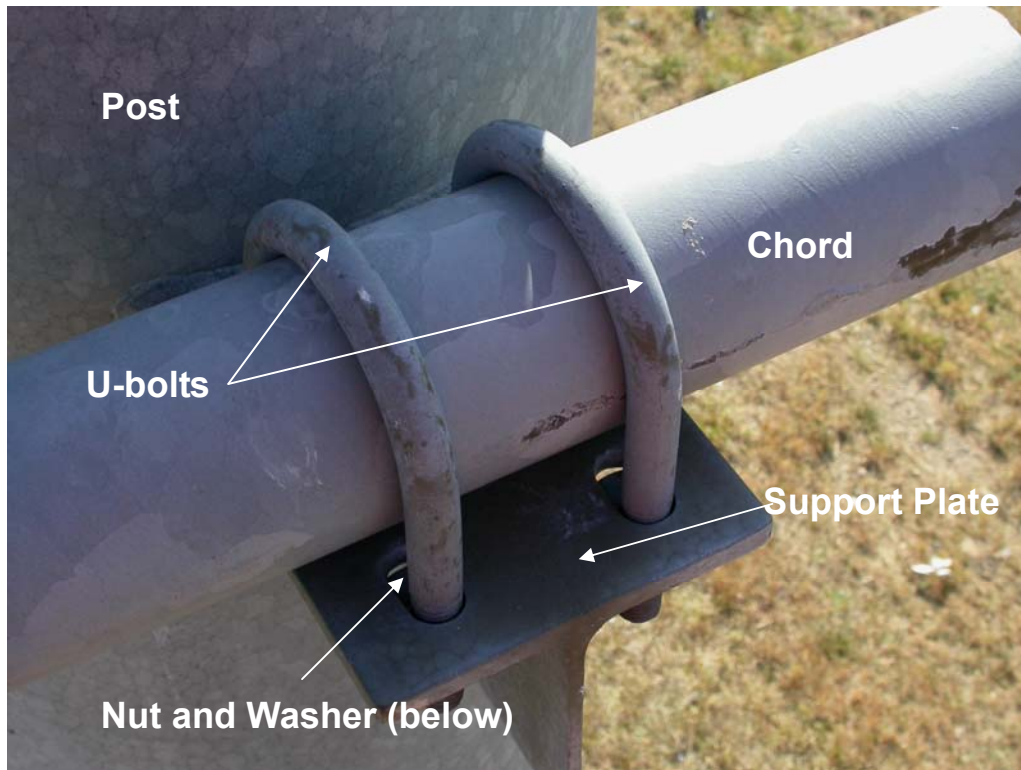


Fig. 51: Chord-to-support-post U-bolt connection for a tri-chord sign structure.

Check chord-to-support-post U-bolt connection for:

- Snugness of U-bolts around chord
- Tightness of nuts (tap washers with a hammer)
- Missing nuts or washers
- Cracks around bolt holes in support plate
- Corrosion on U-bolts, chord, and support plate

Tri-chord Sign Structure

Support-Plate-to-Post Weld Connection

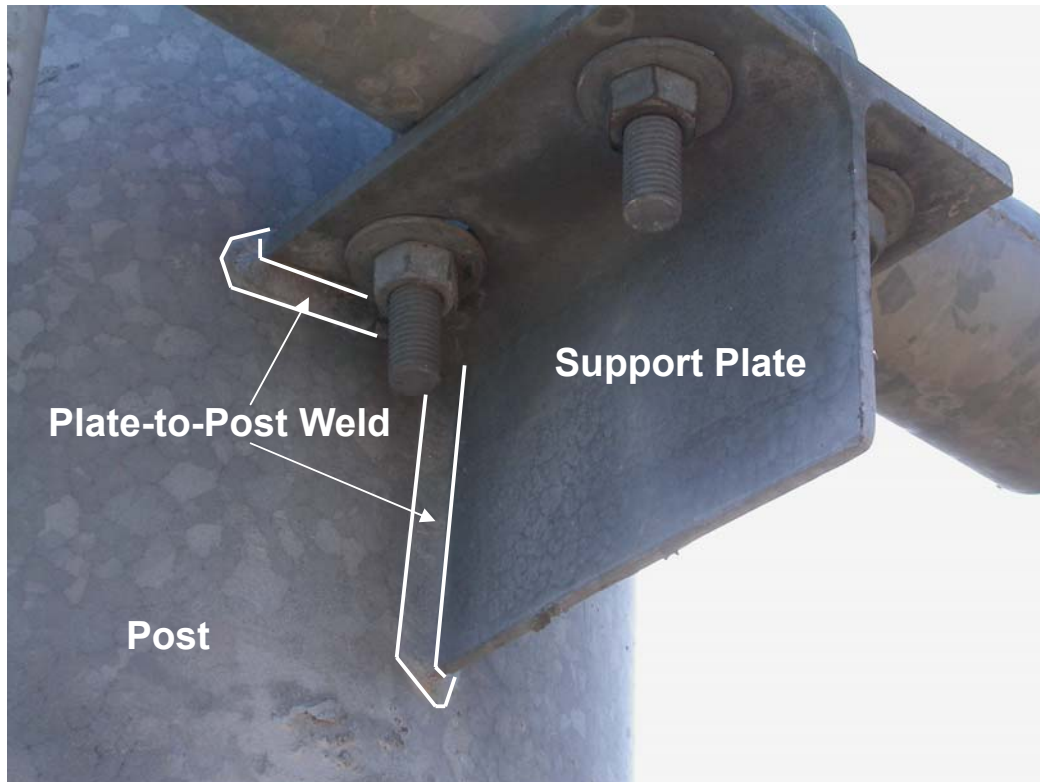


Fig. 52: Support-plate-to-post weld connection for a tri-chord sign structure.

Check support-plate-to-post weld connection for:

- Cracks and irregularities along weld toes
- Corrosion of welds

Tri-chord Sign Structure

Chord Splice Bolted Connection

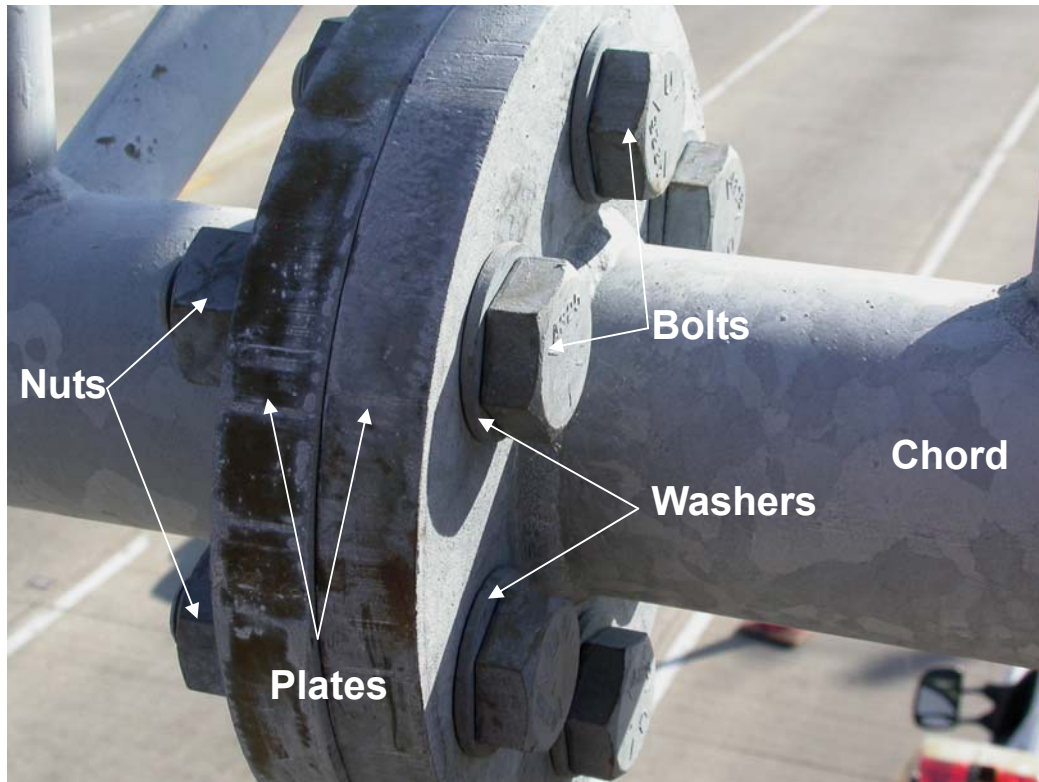


Fig. 53: Chord splice bolted connection for a tri-chord sign structure.

Check chord splice bolted connection for:

- Missing nuts or washers
- Tightness of nuts (tap washer with hammer)
- Condition of bolt by sounding (tap bolt on the top – dull sound indicates possible fracture in bolt)
- Cracks around bolt holes
- Corrosion on surfaces of bolt, nut, washer, and plates
- Signs of corrosion between plates

Tri-chord Sign Structure

Chord-to-End-Plate Weld Connection

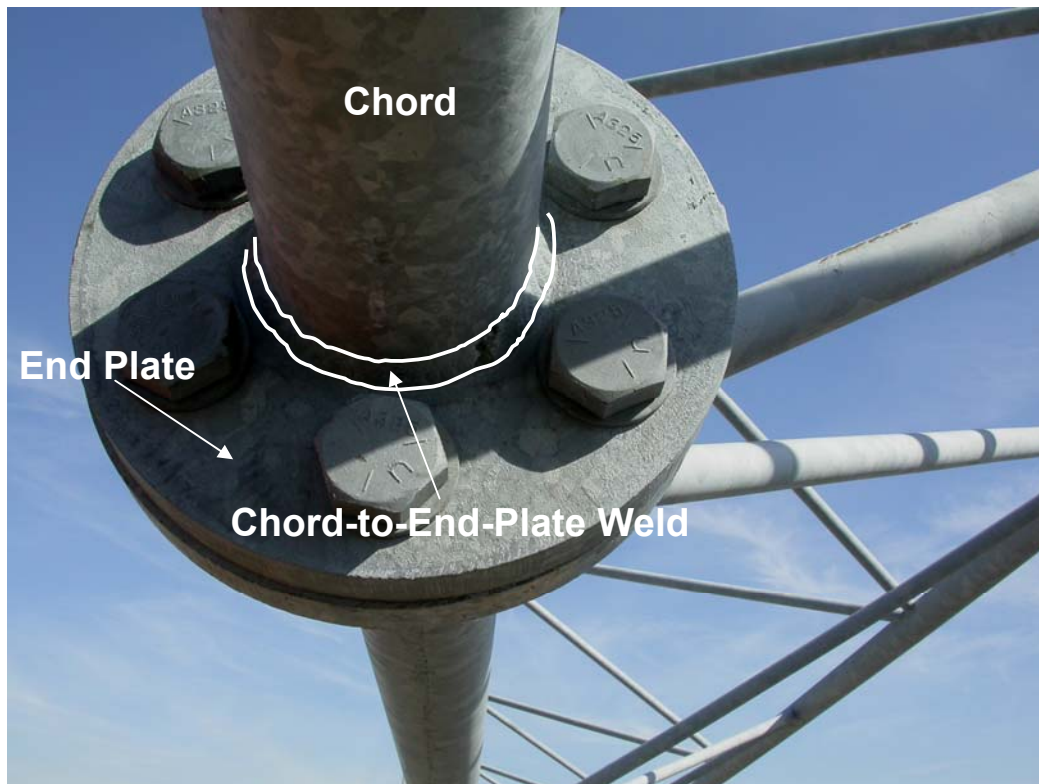


Fig. 54: Chord-to-end-plate weld connection for a tri-chord sign structure.

Check chord-to-end-plate weld connection for:

- Cracks and irregularities along weld toes
- Corrosion of weld and chord

Tri-chord Sign Structure

Truss-Member-to-Chord Weld Connection

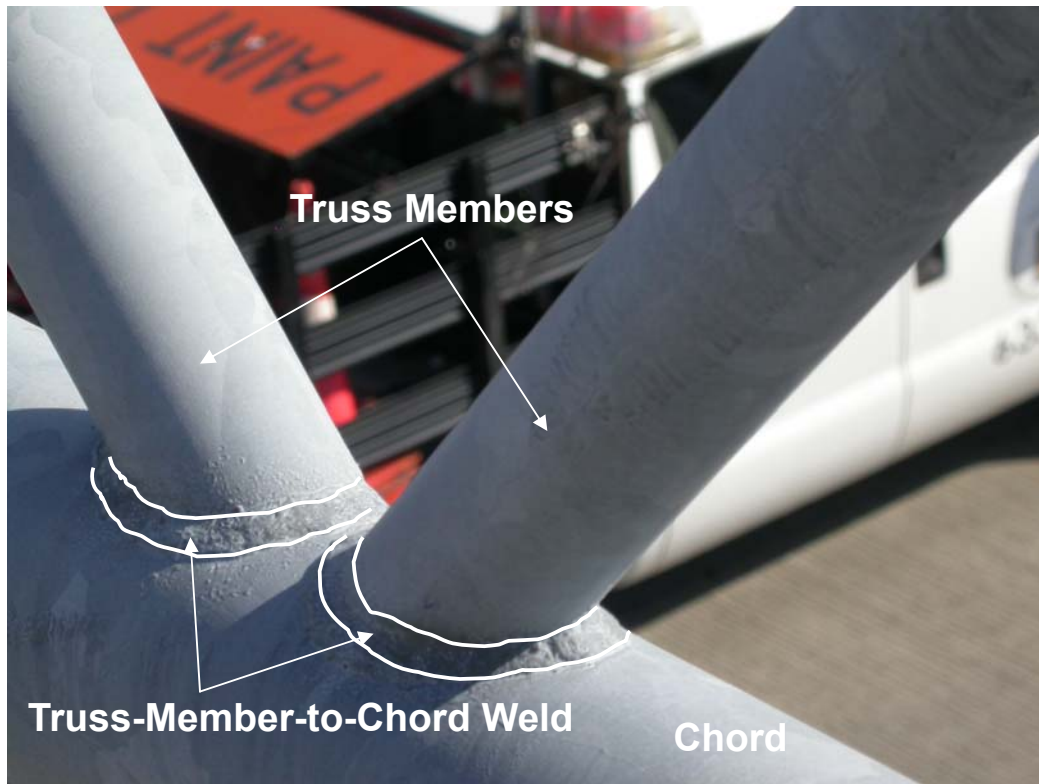


Fig. 55: Truss-member-to-chord weld connection for a tri-chord sign structure.

Check truss-member-to-chord weld connection for:

- Cracks and irregularities along weld toes
- Corrosion of weld, truss members and chords

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